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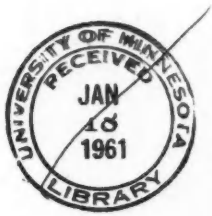

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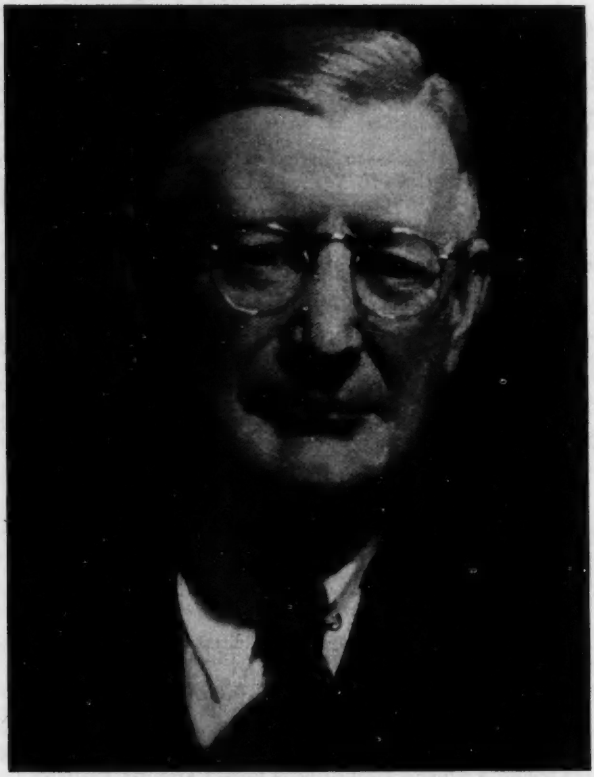


GEORGE FRANCIS CAHILL, M.D.
1890–1959

George Cahill, a great urologist, who walked among us so recently that we are still more startled by his absence than we were by his presence, will always be remembered as a friend by many of us and as an inspiring teacher and leader of all of us.

George Cahill died July 24, 1959, ending a career which brought him international fame. He graduated from Yale Medical School at the age of 21. Moving to New York City he took his internship and residency training at Bellevue and the Post-Graduate Hospitals. Appointments to their attending staffs followed and at the time World War I was declared, he had risen to the rank of associate professor.

World War I found him serving with a mobile surgical unit at the front. His outstanding performance of duty brought to him the command of Base Hospital No. 119, U. S. Army AEF France.

Returning to New York at the cessation of hostilities, George Cahill was appointed to the staffs of Presbyterian, Roosevelt and Willard Parker Hospitals and made a member of the faculty of Columbia University College of Physicians and Surgeons.

The Squier Urological Clinic opened at the Medical Center in 1928. George Cahill was appointed a member of the staff. There he served with great distinction and upon the retirement

of Dr. J. Bentley Squier in 1939, was made director of the clinic and professor of urology at Columbia University.

His outstanding contributions during the intervening years are known throughout the world—particularly diagnosis and treatment of diseases of the adrenal glands. To urology he gave surgery of the adrenal glands to have and to hold, if we will.

Upon George Cahill was fittingly bestowed the highest honors his colleagues and the world could give him; the presidency of this society, the American Urological Association, the Clinical Society of Genito-Urinary Surgeons, the International Society of Urology, the Board of Urology and the Medical Board of the Presbyterian Hospital.

He was awarded the Barringer Medal by this society.

Columbia University honored him with the degree of Doctor of Medical Sciences. The public press and medical journals have recounted his splendid contributions to medicine, surgery and urology and also the high honors bestowed upon him by his colleagues. His friends and patients remember all that he meant to them and the deep and kindly interest that he took in the needs of all who knew him.

I am sure that we pay the tribute of the hundreds of his associates who admired him as a physician, who respected and honored him as a man and who appreciated and enjoyed him as a friend—L'Envoi.

GEORGE WINTHROP FISH, M.D.

HARRY CULVER, M.D.
1885–1959

Dr. Harry Culver, or Bud as he was widely known to his friends, died August 5, 1959, while vacationing at Gleneagles, Scotland, at the age of 73.

He was born at Cobb, Wisconsin. He received his earlier education in that vicinity and graduated from the University of Wisconsin in 1910, with a Bachelor of Science degree. During his college days he was a varsity baseball and football letter man, and until his death was very active in all alumni athletic affairs and was a generous contributor to the scholarship fund of the University.

Dr. Culver obtained his Doctor of Medicine degree from Rush Medical School in 1913, interned at Cook County Hospital and was a research fellow at the Sprague Memorial Institute 1915–16. He spent three years in clinical research in bacteriology at the University of Illinois, where he received his Master of Science degree in 1918.

Following his entry into World War I he took a very active role in the field of urology and was responsible for the development of such a department at the Cook County Hospital and was chief until 1946.

Dr. Culver was head of the department of urology at St. Luke's Hospital in Chicago until his retirement in 1949. He was assistant professor of urology at the University of Illinois until 1927. This was followed by a long career at Northwestern University. Those men who served a preceptorship under Bud Culver will always remember him as a good teacher, a tireless worker and an inspiration to his students. To urology he contributed numerous articles on various genitourinary subjects. He was a member of all the urological associations and served as secretary of the American Board of Urology from 1947 through 1955.

Besides his medical activities, he was an avid sports enthusiast.

We extend to his wife our heartfelt sympathy and we shall always cherish the memory of a loyal friend.

NORRIS J. HECKEL, M.D.

J. DELLINGER BARNEY, M.D.
1878–1959

James Dellinger Barney, known to his friends as Del, was born in Boston in 1878. He attended Harvard College, where he was active in undergraduate affairs, and the Harvard Medical School from which he obtained his M.D. degree in 1904. Then he commenced his life-long association with the Massachusetts General Hospital, starting with a surgical internship. He early became interested in the then nascent specialty of urology, and when the Massachusetts General established a new separate department of urology in 1911, with Hugh Cabot as its chief, he joined it. When Dr. Cabot resigned in 1919, Dr. Barney succeeded him as chief, and also became assistant professor of urology at Harvard—posts which he held until reaching the retirement age of 60 in 1938. That year was a very hard one for him because, in addition to having to give up his service and teaching at the hospital and the school to which he was strongly attached, his two daughters married and left home, and worst of all Mrs. Barney, to whom he was devoted, and who had suffered from severe asthma for many years, died. After 1938 he continued in private practice in Boston at a gradually lessening pace until a slight shock in 1950 forced him to retire completely. After this, he no longer could drive a car, and his physical strength and endurance failed. He spent his last few years in a nursing home where he died December 22, 1959 in his 81st year.

Dr. Barney belonged to a number of professional societies, such as the American College of Surgeons and the American Urological Association. He became a member of this society in 1912, and frequently contributed to its programs.

Also he wrote a number of articles on urological subjects which were published in various journals.

Despite his bluff manner, he was quite reserved and hard to get to know well. He was very fond of nature and of the country, and every Friday afternoon except in winter, he was off to his country place in New Hampshire for the weekend. There he enjoyed studying nature, puttering about his place and working with his hands, and doing odd bits of carpentry, plumbing, etc. Although he was partially color-blind, and therefore worked in black and white with pen or pencil, he was fond of drawing, especially wild flowers. He had occasional exhibits of his drawings of which he sold a number to museums and collectors.

While Dr. Barney made no major contributions to urology, he was an excellent practising urologist, sensible and steady, and in his day one of the prominent members of his specialty in New England.

RICHARD CHUTE, M.D.

ALFRED TOWNSEND OSGOOD, M.D.
1872–1959

Alfred Townsend Osgood was born in Upland, Pennsylvania, October 14, 1872. He attended Andover Academy, obtained his A.B. at Yale in 1895 and his M.D. from Columbia College of Physicians and Surgeons in 1899. He was an intern at Presbyterian Hospital 1899 to 1901 and did graduate work in urology in Berlin during 1902 and 1903.

Dr. Osgood became an associate of Dr. Tilden Brown, outstanding surgeon and teacher and co-developer of Brown-Buerger cystoscopes and other instruments, and participated in the development of urology as a full-fledged specialty. He was active on the staffs of numerous metropolitan hospitals, and took an active part in the New York County Medical Society and the New York Academy of Medicine. He became a fellow of the American College of Surgeons and a diplomate of the Board of Urology.

Next to Dr. Alfred Wood, he was one of the oldest members of this society having been elected in 1906.

He served two terms as president of the New York Urological Society. He was professor of urology at New York University College of Medicine from 1912 to 1936, where he was known for his teaching ability as well as his devotion to Bellevue's patients.

He was married in 1914 to Ethna MacKaye. They had no children. Mrs. Osgood died in 1955.

Dr. Osgood gained considerable professional fame by operating upon former Secretary of State Elihu Root in his home when the patient refused to go to a hospital. He also carried out a successful operation on a member of an outstanding Cuban family; he took with him, by ship, a complete operating room set-up and a corps of assistants and remained with his patient 6 weeks until he had completely recovered.

Dr. Osgood was one of the founders of Doctors' Hospital in New York. He became president of the Medical Board in 1940 and was active in all its affairs of the hospital until his retirement in 1945.

Dr. Osgood was forthright in his opinions, uncompromising in his ideals, and he was honored and loved for his sincerity, his honesty and his devotion to his patients.

JOHN A. TAYLOR, M.D.

ALFRED C. WOOD, M.D.

1863–1959

Alfred C. Wood, a senior member of the American Association of Genito-Urinary Surgeons, died at his home in Philadelphia October 2, 1959. Dr. Wood was born in 1863, in the days of the Civil War, and had therefore reached the venerable age of 96 at the time of his death.

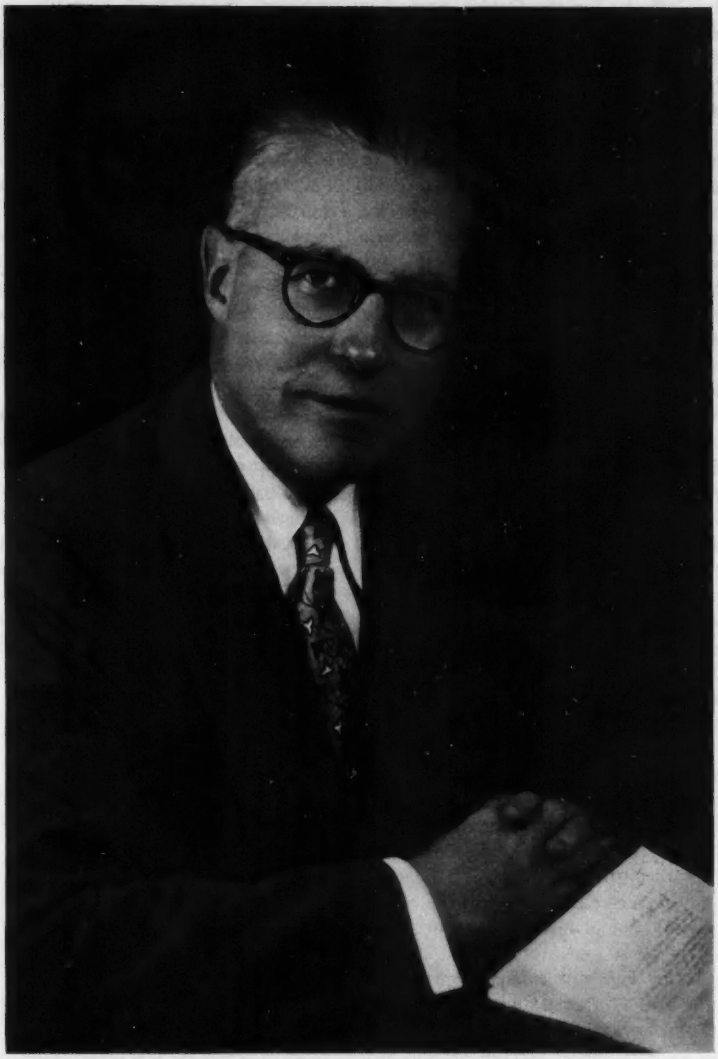
He was graduated from the Philadelphia College of Pharmacy and from the Medical School of the University of Pennsylvania, where he served as intern in the University Hospital in 1888 and 1889. He then joined the staff of the hospital and was closely associated for many years with Dr. J. William White, the head of the surgical staff, and the first professor of genitourinary surgery in the country.

Dr. Wood became chief of surgery at St. Agnes Hospital in Philadelphia and at Memorial Hospital in Roxborough, Pa., and chief of staff at Howard Hospital in Philadelphia. On the teaching staff of the University of Pennsylvania he rose to be assistant professor of surgery. He was elected to membership in this society in 1900, so that his name graced its rolls for 60 years. In addition he belonged to the Philadelphia County Medical Society, the American Medical Association, the International Surgical Society and the Union League of Philadelphia. He wrote numerous books and articles, largely in collaboration with Dr. White. He was married to Dorothy Donnelly, who survives him, as do his son, Dr. Alfred C., Jr. and three grandchildren.

Dr. Wood retired from active professional life in 1928. He retained health and spirit during 32 years of retirement, but the infirmities of his great age have prevented attendance at meetings of the society for some time.

The society, grieved at his passing, extends its sincerest sympathy to his family, and salutes his long and useful career.

DAVID M. DAVIS, M.D.



PRESENTATION OF KEYES MEMORIAL MEDAL TO VINCENT J. O'CONOR, M.D.

Dr. Reed M. Nesbit: Vincent John O'Conor, I have the happy privilege of bestowing upon you in behalf of this society its greatest distinction: the award of the Keyes Memorial Medal. You have been selected for this honor because of many attributes that have characterized your personal as well as your professional career.

Your father and your father's father were distinguished lawyers and your father, like Abraham Lincoln, was a member of the Senate in the State of Illinois. He later migrated West

and was, for a time, comptroller of California. Perhaps this affinity for the Golden State has been an influencing factor in your own selection of a winter home on the Monterey Peninsula.

You attended Holy Cross College for one year before transferring to the University of Michigan where you obtained the baccalaureate in 1915. You graduated from Rush Medical College in 1918, then served an internship at Presbyterian Hospital in Chicago. After serving a surgical residency in Boston, you became the first man ever to be a urological resident at Peter Bent Brigham Hospital, under Dr. William C. Quimby. Returning to Chicago you entered the private practice of your specialty and also embarked on a career of teaching, and have distinguished yourself as chairman of the urology section in Northwestern Medical School.

You were married to Catherine Carey in June 1922 and have enjoyed the blessings of a happy and rewarding family life. Your two daughters and your son have provided you and your devoted wife with 17 grandchildren. You have practiced your religion proudly and with devotion. Your great capacity for enduring friendships has been enhanced by a love for an ancient outdoor Scottish game that you have played with skill and conviviality on nineteen hole courses all over the world.

Your professional accomplishments have enriched the medical literature with over a hundred publications and your operation for the cure of vesicovaginal fistula has been a significant contribution to the management of this distressing affliction.

You have been associated with all of the worthwhile medical and surgical organizations that touch upon your field of specialization and you wear the key of Alpha Omega Alpha. You have been a member of our association for 34 years and were president in 1944. You have served on the membership committee for a score of years and in this capacity have been an important influence in maintaining the status of our organization as the most distinguished urological society in the world.

Finally, you are held in respect and affection by every member of this association. Few of us have the good fortune to have your widespread group of friends. Rarely is there a urologic gathering in any part of the world from London to Brisbane where some do not speak of you and call you friend; many of these you have encouraged and helped.

Vincent O'Conor, I am honored now on behalf of the American Association of Genito-Urinary Surgeons to present to you the Keyes Memorial Medal.

PYELONEPHRITIS AND THE UROLOGIST

MYRON H. NOURSE

From the Department of Genito-Urinary Surgery, Indiana University School of Medicine and Methodist Hospital, Indianapolis, Ind.

One year ago, Prather and Scars made an excellent presentation on the subject of "Pyelonephritis: In Defense of the Urethral Catheter." They stated: "Urologists, whose experiences now cover a period of about fifty years as a specialty, have developed great respect for the possible dangers involved by the use of urethral instruments and should be qualified to discuss their proper use."

Interest concerning pyelonephritis is clearly demonstrated by the extensive publications on the subject. It seems to be out of all proportion, however, to the knowledge gained. In fact, there is much that is misleading and bears a "second look." Most of the published work has come from the laboratory by those unfamiliar with fundamental urologic principles that are part of the everyday life of today's well trained urologist. This is no reflection on the laboratory or those capable persons devoted to its particular branch of medicine but rather appreciation that this is a statement of fact and not fancy.

We turn to the internist regularly to help us evaluate and treat the cardiac, the hypertensive or the diabetic patient who needs a prostatectomy, because we value and appreciate his knowledge and because the patient receives better medical care. The urologist also depends upon laboratory workers for accurate interpretation of microscopic slides. By the same token, the internist and the pathologist turn to us for an opinion or treatment when confronted with an urologic problem. Each respects the other for his training, his knowledge and his experience and it is therefore important that we work together harmoniously for benefit of the sick.

Presuming then that each contributes a part, it seems reasonable to expect the urologist to evaluate data regarding urinary infection and pyelonephritis because most of the reports are by those of nonurologic groups and reflect upon the judicious use of the "tools of the trade."

For the benefit of some, it is vitally important for them to know that, except within the urethral meatus in both sexes, normally the urinary tract is sterile. As Davis states, "The normal urinary tract should remain free of bacteria from the cradle to the grave. Even if the bacteria are introduced into a perfectly normal urinary tract, they will be spontaneously eradicated in, at most, a few days." Davis says further: "If persistent infection occurs in the urinary tract it will usually mean urinary stasis due to obstruction to the normal urinary flow. All changes produced are reversible in the early stages and irreversible in the late stages. It is therefore the duty of the physician to learn to detect the obstruction in its early stages, and relieve it before irreparable damage is done."

O'Conor has reported that in his experience, more than 75 per cent of patients with recurrent or persistent urinary tract infections have obstructive lesions, neoplasms or calculi.

These comments represent fundamental urologic teachings of yesterday and today. They are every bit as sound now as before and I question that this is appreciated by the majority of those who are not in the practice of urology. This fact is confirmed and well illustrated in a recent statement by Kass who asks the question: "Why does bacteriuria not persist in most individuals into whose bladders bacteria are frequently inoculated by various instruments?" He further states, "Although it is commonly argued that small degrees or obstruction account for persistence of bacteriuria, there is inadequate evidence to support this view in most instances of asymptomatic bacteriuria and, in any event, the concept of obstruction does not explain why the normal bladder clears itself of bacteria nor how obstruction interferes with the clearing mechanism."

Talbot concluded that it is the development of *obstructive* lesions in the upper urinary tract that leads to significant renal infection. He bases this on a study of 50 patients with spinal cord injury or disease wearing indwelling urethral catheters from 1–14 years. Although all had bacteriuria, 72 per cent showed no clinical evidence of renal disease.

Frequent reference is made to the published work of MacDonald and associates concerning their autopsy study of 100 patients. Much time and effort were expended in the preparation of their report. However, several statements are misleading in the sense that some may be interpreted differently and others require exemplification. For example: "Active or *healed pyelonephritis*, or both, occurred in 33 per cent of the patients." Is this out of proportion to pathological processes found in other organs of the body? Over 50 per cent of the patients had hearts that weighed 400 gm. or more. Better than 30 per cent had hypertension.

Breakdown of the 33 per cent who had active or healed pyelonephritis, or both, discloses that 18 per cent were *healed*. Active pyelonephritis was found only in 17 patients, 14 with 100,000 or more bacteria per milliliter or urine and 3 with no or relatively few bacteria.

Our interest as urologists should now become attached to the 17 patients with active pyelonephritis. What other pathologic lesions of the urinary tract existed? Four had benign prostatic hypertrophy; one, carcinoma of prostate; three classed as "acute cystitis," four, hydronephrosis or hydroureter; two, "acute pyelitis," one, retention cyst and two were focal lesions adjacent to septic emboli in patients with acute bacterial endocarditis. With the exception of the two focal lesions, the rest seem to fall in with our original thinking that persistent infection is presumptive evidence of obstruction and stasis.

MacDonald further says the clinical diagnosis of active infection of the urinary tract was not made in 70 per cent of cases in which active pyelonephritis occurred. This actually is no more than 11 or 12 patients, two of these being focal lesions resulting from septic emboli in patients with acute bacterial endocarditis which was the *primary* disease. One cannot tell if other disease in the remaining 9–10 patients contributed to or caused their death. Certainly there was enough evidence of pathologic lesions of the urinary tract found at autopsy and represented by obstruction to account for most, if not *all*, the rest. The urologist's interest is again aroused and he wonders if urologic counsel was sought prior to death. In other words, the aforementioned 70 per cent may also be interpreted as about 10 per cent of the total 100 autopsies, and further corrected would probably be no more than 5 per cent clinically undiagnosed active pyelonephritis. This should be considered within the reasonable range of error in this particular study.

Pyelonephritis is the commonest complication of pregnancy. Kass found that about 6 to 8 per cent of 2,000 pregnant women making their first prenatal (before the second month) visit had asymptomatic bacteriuria and that in more than 40 per cent of these pyelonephritis developed if the patients were untreated. None developed pyelonephritis if appropriate chemotherapy or antibiotics were used. The value of chemotherapeutic agents in the prophylaxis of urinary tract infection has been further emphasized by Davis. Kass also noted that pyelonephritis never occurred in any patient who did not have bacteriuria at the time of the first prenatal visit and that bacteriuria often persists for months or years post partum in untreated patients. His following comment further emphasizes the importance of urologic counsel when he says "that the factors leading to the maintenance of bacteriuria are not at all clear."

I repeat, persistence of urinary infection is presumptive evidence of obstruction or primary urinary tract disease and this will only be determined after a careful, competent and adequate urologic survey. This will by necessity require urethral instrumentation. Confidence should be given to those who are properly trained to use these instruments.

Boyce aptly states that "pyelonephritis in current concepts of clinical symptoms, gross and microscopic pathologic anatomy, alterations in the urine and urinary sediment, and enumeration of bacteria in the urine has become as nonspecific a term as 'Bright's disease.' Is it too much to ask that physicians apply current knowledge rationally and diligently to the prevention and therapy of urinary infections?"

O'Conor urges that the need for careful, complete diagnostic survey of the entire urinary tract has not been changed by the efficiency of modern antiobiotics. He states: " 'Fancy' may suggest positive chemotherapy, but 'Fact' emphasizes that 'cure' can only be obtained when urinary tract obstructions have been properly corrected."

SUMMARY

Current usage of the term pyelonephritis seems unusually complex and nonspecific.

An attempt is made to stress a few important, fundamental urologic principles which often

are not fully appreciated by those who are *not* in the practice of urology.

Interpretation of some of the published data concerning pyelonephritis is attempted from the viewpoint of the urologist realizing that we must work together for the benefit of the sick.

Complete, competent and adequate diagnostic survey of the entire urinary tract is necessary when urinary tract infection persists. Nothing will replace it.

Respect must be given to the judgment of those properly trained in the procedures associated with urethral instrumentation.

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ACUTE MONILIAL BALANITIS

B. MARVIN HARVARD

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In standard textbooks on urology scant attention is paid to fungus infections of the genitalia and urinary tract. Yet, in recent years the problems posed by them seem to be increasing in frequency and severity.[1] One such problem, acute monilial balanitis, has recurred in our clinic often enough to allow a description of its clinical manifestations as well as suggestions for treatment. While genital fungus infections in the male have been described by dermatologists for many years, the emphasis in their writings has been on the intertriginous[2] and ulcerogummatous type.[3-5]

An early description of the condition under consideration here, in which the lesion in the male is described, was published by Odland and Hoffstadt.[6] They cite a case of balanitis-vaginitis in a young married couple. While the history in their case is typical of many, the penile lesion described is not as characteristic as those we have observed. They described "a thin, fairly adherent, scaling band . . . on the corona glandis. The scales appeared as a thin film on the surface and were grayish-white." From these scales they recovered Monilia pinoyi.* The woman was found to have typical vaginal thrush and M. pinoyi on culture. Treatment, presumably administered to each, consisted of gentian violet alternated with silver nitrate. It provided relief of the condition. Perhaps the earliest authoritative study of the role of this fungus in genital moniliasis is that of Castellani and Taylor[7] in which they described the lesion in women as well as methods for demonstration of the organism.

Over the years there has been some doubt cast upon the role this fungus plays in causing disease. Many have pointed out the fungus' ubiquity as well as the fact that monilia taken from a person who shows no clinical evidence of the disease is identical with that taken from a patient displaying clinical disease; furthermore, that organisms from either source are equally capable of producing clinical disease under favorable circumstances. The opinion of most observers seems to be that in those patients exhibiting clinical moniliasis the host has been modified in some manner. Clinical observations support this view. The marked increase in the incidence of gastrointestinal and vaginal fungus infections following suppression of normal bacterial flora by antibiotics is an example. Having observed patients with the conditions described below and noted their clinical response to therapy designed to combat fungi, it is difficult not to conclude that there is, indeed, a causal relationship between the fungus and the observed lesion.

The typical patient is uncircumcised and presents himself complaining of itching of the prepuce and a slight watery discharge. He is usually young, married, and his wife has borne children. The condition has been observed, however, in young, unmarried sexually active males as well as in one elderly, married sexually inactive patient. Not infrequently a history of vaginal discharge in the sexual partner can be obtained. Conversely, in one newlywed patient, a clinical diagnosis of acute moniliasis was made with recommendation that his wife be examined. A confirmation of the diagnosis was made by her gynecologist.

Examination of the penis will reveal a reddening and mild edema of the preputial orifice and

* Candida albicans

[1] Davis, J. B., Whitaker, J. D., King, L. K. and Kiefer, J. H.: Disseminated, fatal, postpartum candidiasis with renal suppression. J. Urol., **75:** 930–936, 1956.

[2] Higdon, R. S.: Intertriginous moniliasis in far Eastern command. AMA Arch. Dermat., **74:** 620–626, 1956.

[3] Thal, M.: Ulcero-gummöse Soorinfektion der Glans Penis. Dermatologia, **114:** 368–376, 1957.

[4] Ormsby, O.S. and Montgomery, H.: Diseases of the Skin. Philadelphia: Lea & Febiger, 1954, p. 1197 et seq.

[5] Sutton, R. L.: Diseases of the Skin. St. Louis: C. B. Mosby, 1956, p. 546 et seq.

[6] Odland, H. and Hoffstadt, R. E.: Eruption on the genitalia due to a fungus. Arch. Dermat. & Syph., **20:** 335, 1929.

[7] Castellani, A. and Taylor, F. E.: Vaginal monilias and vaginal moniliases. J. Obst. Gynec., British Empire, **32:** 69, 1925.

glans penis and the presence of a serous discharge. Upon retraction of the prepuce a characteristic lesion often will be observed. Over the surface of the glans and coronal sulcus and occasionally on the contiguous surface of the prepuce there will appear varying numbers of flat, bright red, circinoid patches measuring a millimeter or two in diameter. They may be contiguous, confluent, or widely scattered (fig. 1). Over many may be seen thin, whitish membranous patches. The discharge may be thin and watery or, occasionally, milky and represent a purulent secretion. In scrapings from the lesion one can often demonstrate the typical pseudohyphae of monilia and culture of the material frequently will be positive for Candida albicans.

While an attempt is made in each case to demonstrate the presence of the fungus by smear or culture, the clinical picture has proven so characteristic that specific treatment is begun whether or not the organism has been found. Clinical results have been excellent up to the present. Symptomatic relief has been achieved, not only in the male, but in his sexual partner as well provided a program of simultaneous treatment is followed. A jelly consisting of 10 per cent calcium propionate and 10 per cent sodium propionate has proved to be efficient in controlling the fungus in both male and female and in bringing about fairly prompt relief of symptoms. Each night before retiring, the male applies the jelly to the preputial cavity thoroughly as well as anointing the shaft of the penis, the scrotum, contiguous thigh areas, and pubes. In the morning the residual jelly is washed from the preputial cavity and the cavity carefully dried. One patient did not rinse the cavity but continued to add more jelly each day for several days which resulted in a very painful chemical burn of the glans penis. The female, meanwhile, is carrying out a similar program of instillation of jelly into the vagina as well as anointing the labia, clitoris, contiguous thighs, and pubes. Generally, the treatment is discontinued after a week although in severe cases the gynecologist may direct that the treatment be continued for longer periods.

Following symptomatic relief and disappearance of the lesion circumcision is urged upon the patient. In those who will accept it there have been no recurrences to date, while in those who have refused it there have been relapses.

It is here that another aspect of the problem has been encountered. Two patients whose wives had chronic, intractable monilial vaginitis with severe vaginal symptoms and marked dyspareunia were referred for examination as possible sources of continued infection. Each was uncircumcised and showed clinically recognizable lesions of monilial balanitis but in such mild degree that neither was aware of its presence. The characteristic tiny red macules were the only sign present. There was no discharge, no itching, nor was the fungus demonstrated on smear or culture. However, circumcision, followed by simultaneous application of calcium-sodium propionate jelly to both husband and wife, resulted in complete symptomatic relief for the women. Undoubtedly this type of male "carrier" accounts for some instances of failure in the management of monilial vaginitis.

Three representative case histories are presented:

CASE REPORTS

Case 1. M. V., a 30-year-old, white father was referred for examination as a possible "carrier" because of his wife's intractable monilial vaginitis and marked dyspareunia. Examination revealed normal genitalia with a readily retractable prepuce. No discharge was present. Around the coronal area of the glans penis there were "a few punctate, reddened areas." They were scarified with a sterile, wet sponge which was sent for mycological examination and found positive for C. albicans. The patient was circumcised and ultimately both husband and wife were treated with calcium-

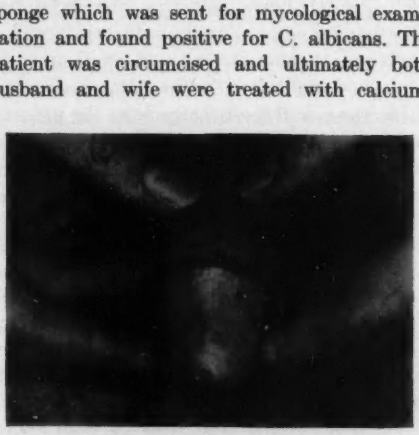

FIG. 1. Typical distribution of bright red macules on glans penis and mucosal surface of prepuce in acute monilial balanitis.

sodium propionate jelly. Six months later, after happily resuming normal marital relations, the wife showed no clinical evidence of moniliasis and vaginal culture was negative for C. albicans.

Case 2. L. B., Jr., a 25-year-old, white newlywed complained of a "discharge." Examination revealed a serous discharge from the preputial meatus and the visible mucosal edge of the prepuce was reddened. On retraction of the prepuce "irregularly patchy areas of erythema on the glans penis and mucosal surface of the prepuce" were noted. Smears suggested monilia; cultures were not reported. The lesion was typical enough for the examiner to recommend that the patient's wife be examined by a gynecologist. She was found to have monilial vaginitis. Simultaneous treatment with calcium-sodium propionate jelly produced clinical cure. Circumcision was refused. There had been no relapse when the patient was lost to observation 7 months folowing treatment.

Case 3. M. W. C., a 65-year-old white man with cardiac asthma, an extensive history of allergy, mild prostatism and who had been sexually inactive for several years, was referred because of swelling and itching of his penis and difficulty in urination present about three days. He had been treated with a steroid ointment without relief. The day before the beginning of his present illness he had a tooth extracted and had been given demethylchlorotetracycline HCl for 24 hours following the extraction. Shortly after completing the antibiotic treatment he began to note itching and swelling of his penis and difficult urination. On examination there was a watery discharge from the preputial cavity and upon retraction of the foreskin there was present over the glans and mucosa of the prepuce a bright red macular rash which was weeping. The lips of the external urinary meatus were swollen and the glans was mildly edematous. The scrotum was retracted, edematous, moist, and itching. There was a slightly excoriated area near its junction with the perineum. The prostate was enlarged and benign. Residual urine 50 cc was present. Culture was positive for Candida albicans. Daily application of calcium-sodium propionate jelly to the affected area resulted in prompt symptomatic relief.

Thus it would seem from these observations that fungi——particularly Candida albicans——can and do occasionally cause acute superficial balanitis with recognizable clinical features which will respond satisfactorily to appropriate therapeutic measures. One is curious, of course, as to why the lesion is not encountered more often. The combination of factors necessary to modify the host for the development of the lesion is not known. Further, the role of the male as a "carrier" in chronic, recurrent monilial vaginitis is undefined. All "carriers" in our experience have been uncircumcised. One wonders if the circumcised male cannot act in a similar manner and, if so, whether standard treatment for female moniliasis should not include simultaneous treatment for the male.

SUMMARY

Acute monilial balanitis is characterized by itching, inflamed, weeping mucosal surfaces of the glans penis and prepuce upon which may be noted tiny, bright red macules sometimes covered with whitish membranes. Candida albicans may be demonstrated on smear or by culture. Appropriate treatment in the male is a topical fungicide and circumcision. Representative case histories are presented. Its venereal character and the role of the male "carrier" in chronic, recurrent monilial vaginitis are pointed out.

DISCUSSION

DR. JOHN A. TAYLOR (New York, N. Y.): I would like to mention a case I saw of monilial infection that was very interesting.

I first saw the patient in 1950 with acute retention. He had a large, pedunculated tumor which I removed transurethrally, with a diagnosis of papilloma, grade 1. He refused radiotherapy. He was a marked diabetic and he had inguinal, scrotal and perineal weeping eczema.

A year ago an abscess developed on his abdominal wall that extruded into the scrotum and the femoral region. The abscess was opened. Postoperatively he took a lot of antibiotics. Five months later, cystoscopy disclosed what looked like a nest of stones in the bladder. There were a lot of small balls about 1 cm. in diameter. I could get no click, so I figured I was dealing with some soft material, and with an Ellik evacuator I evacuated 45 cc of this material. On culture, it showed a pure growth of Candida albicans.

Here is where the serendipity comes in: (I discussed this with Dr. Meyer Mellicow who is working with glucuronidase as a carcinogenic agent)—could it be that the yeast in its metabolism had neutralized some carcinogenate? He thought it possible. The patient went for 8 months, while he was being treated, without a recurrence, and before that he had never gone over three months without a recurrence.

DR. J. HARTWELL HARRISON (Boston, Mass.): I feel very strongly that Dr. Nourse, Dr. Prather and others deserve commendation for meeting the challenge of confused teaching which has emanated from various sources, a prominent one of which is New England, in regards to what causes urinary infection. These men have accomplished much in defining the problem of the catheter and its relation to urinary infection. It is hard to believe that anyone would seriously deny that organisms enter the urinary tract from distant foci of infection in the body and that hematogenous spread to the kidney occurs as an important source of renal infection, pyelonephritis and abscess of the kidney. Improper instrumentation of the urinary tract can certainly cause infection and it has been well known for several decades that the catheter may incite bacteria to invasion of tissues.

Dr. Robert E. Desautels has shown definitely that the urethral catheter can be used without causing infection in a significant percentage of cases. By using very careful aseptic technique in the handling of the catheter and by using regular daily cleansing and a zephiran dressing marked improvement in postoperative infection was observed by him. Fifty-one patients were followed carefully after prostatectomy and 41 were discharged from the hospital with negative urinary cultures whereas 10 had positive cultures at the time of discharge from the hospital. Dr. Carl Walter has suggested the impregnation of the rubber catheter with a bacteriostatic agent. Dr. Desautels has used this type of catheter in 35 patients undergoing prostatectomy. Thirty-two had negative urinary cultures when discharged from the hospital and three had positive cultures. Even the most severe critic will admit on the basis of this evidence that the catheter can be used safely.

DR. DAVID M. DAVIS (Haverford, Pa.): I would like to say a word in connection with Dr. Nourse's splendid paper and to congratulate him upon it.

Some of us have raised our voices on this subject, as Dr. Harrison suggests, particularly at the International Symposium on Pyelonephritis held here in Detroit last October.

We must of course try to combat this false teaching; but on the other hand there are a few things that we urologists must do also. We have no proper criteria for minimal degrees of obstruction particularly in the upper urinary tract. The x-ray is not sufficient.

I think the ultimate answer will have to come from studies of pressures existing in the upper urinary tract rather than from shadow pictures such as we get in the x-ray.

Also, I think we should try to spread our knowledge about the usefulness and value of stained smears of the centrifugalized sediment of freshly obtained urine. This test is so simple, so easy, so rapid and so inexpensive that it should be known to every physician, and particularly to pediatricians, gynecologists and obstetricians so that, as Dr. Nourse suggests, all physicians can pick up cases of what Dr. Kass calls "asymptomatic bacteriuria" in the early stages, and not wait until the kidneys have been badly damaged.

Lastly, I would like to mention that Dr. Kass

persists in ignoring the magnificent work done by Dr. E. Granville Crabtree, a member of this Association, in regard to urinary tract infection, including asymptomatic bacteriuria in pregnant women.

Dr. Roger C. Graves (Boston, Mass.): I, too, have enjoyed Dr. Nourse's paper very much.

In line with Dr. Harrison's discussion, I would merely like to say that out of all this recent increased and very proper interest in pyelonephritis there has come, for some strange reason, a wrong emphasis on the use and abuse of the catheter, which I believe was Dr. Nourse's original title.

Of course, no one wants to dispense with the catheter. One wants merely to be sure that it is properly used by those qualified to use it, and with proper respect for the possibilities of infection that accompany its misuse.

I want to say only that the work to which Dr Harrison referred, done by our associate, Dr. Desautels in Boston, is highly worth while. We will let him speak for himself as his publications appear, but I can tell you from firsthand knowledge that the care of the catheter which he is advocating really results in sterile cultures after periods of three and even four weeks of constant catheter drainage or suprapubic tube drainage.

I would like to show you one slide that Dr. Desautels made.

(Slide) This is the drainage system that we use. It has been described before in a paper written by Dr. Buddington. It is quite simple. It is all sterile and is kept completely sterile throughout the period of its use.

The attachments are a two-hole stoppered bottle which is sterile along with the rest of the system when it is put into use. It is changed every 24 hours or so, and with the vent here it is impossible for contaminated fluid in the bottle to return to the bladder if the nurse lifts the bottle up and carries it over above the bladder level to the other side of the bed, for example.

The whole system is maintained with the most rigid aseptic precautions. The connection is never interrupted except with a zephiran or alcohol bath at this point when the connection is broken and when it is re-established.

Because it has been shown more recently that bacteria will ascend the urethra around the catheter, the junction of the catheter and the urinary meatus or the junction of the tube and the suprapubic sinus is cleansed frequently with tincture of zephiran or aqueous zephiran. In male patients, a gauze dressing is kept around the junction of catheter and meatus, and this is impregnated with zephiran.

By this very simple method we are now sending most of our patients home with sterile urine, even though they have had long periods of catheter or suprapubic drainage.

Voice: What concentration of zephiran?

Dr. Graves: 1:1000 aqueous, or the tincture.

Dr. Edwin P. Alyea (Durham, N. C.): I would like to congratulate Dr. Harvard on his timely paper. This is a condition which is far more common than we realize. It is a rather minor lesion and we often pay little attention to it. You give the patient a simple antiseptic of some kind and very often the infection does not clear up. Then you begin to wonder why.

We have had two patients in the last year in whom we have recognized the monilial infection. I would like to ask Dr. Harvard if he has used mycostatin dusting powder put out by Squibb. This cleared up our two patients promptly. One of them had a recurrence on two occasions, and within 48 hours was again entirely cleared by its use. It is a very easy, simple and clean application of the powder. I have seen no signs of chemical irritation of the mucosa when applied twice a day. There is no subjective discomfort at all, and it has been most satisfactory therapeutically.

Dr. Cornelius Vermeulen (Chicago, Ill.): I would like also to refer to the subject that Dr. Nourse brought up, but in a somewhat different fashion.

Most of the discussion here thus far has been clinical. Actually, it would seem to me that the attack upon the catheter has been two-pronged: first, clinical observations; and second, experimental.

Dr. Kass, particularly, has tried to substantiate his arguments with rat experiments. Among other experiments, those that he has done consist of putting bacteria into the bladder of the rat operatively, and then determining the ascent of the organisms into the kidney.

Obviously this is a crucial point, because if you are talking about introducing bacteria into the bladder as a cause of pyelonephritis, the bacteria must get up there somehow.

Dr. Kass has shown that when bacteria are put into the bladder of a rat they very regularly appear in the kidney and produce pyelonephritis, and that if another rat is operated upon and the

ureter on one side is ligated, they do not get up into that kidney but do get up the unligated side.

In our laboratory this has been abundantly confirmed and with refinements that Dr. Kass was not able to use. For instance, the ability to catheterize a rat's bladder, which we can do without trauma now, and introduce the organisms quite apart from any operation. If one ureter has been previously ligated in such an animal, the infection does not get up into that kidney, while it does on the unligated side.

This is very disturbing, a real attack upon the catheter from an experimental point of view. We were still skeptical of the validity of this kind of observation, despite the fact that the experiments were as refined as we were able to make them, and various attempts to explain these observations were made in our laboratory.

Very recently I think we have made an observation that actually vitiates all of the experimental work on this whole subject as it occurs in the rat. If one passes a catheter into the rat's bladder, or if one introduces a catheter into the bladder suprapubically, and injects indigo carmine, it promptly refluxes into the kidney.

That is to say, the rat, an animal that heretofore has not been studied with respect to reflux or regurgitation, happens to be an animal in which this occurs with regularity; and if this be the case, and if in man this is not the case, then all the work that has been done on the rat with respect to the passage of bacteria from the bladder to the kidney has to be thrown out, it would seem to me.

The observations of Dr. Kass on the animals which he uses to support his clinical impressions, I think, cannot be extrapolated to man, and therefore have to be disregarded.

DR. FRANK HINMAN, JR. (San Francisco, Cal.): After Dr. Vermeulen's rather delicate and scientific experiment I would like to describe something a little simpler but which I think points up one of the aspects of the catheter problem rather clearly.

How do we get rid of bacteria from bladders? We know that all of us carry residual urine normally. It is a very small amount, but our bladders are not dry after we finish voiding. As you remember, the shivering which occurs at the end of voiding, Aristotle said, was because of aspiration of cold air back into the bladder. Scientific experiments have proved that this is not so. So, we do have residual urine of a small amount.

Therefore, do we get rid of the bacteria by hydraulically washing the bladder out daily, regularly, or is there some intrinsic protective mechanism? I think this is the key to our thinking about this problem.

I obtained a plastic flask, sterilized it, voided into it, and had it inoculated with bacteria to 2×10^4. This was cultured and counted. Then I carried it in my hip pocket at approximate body temperature, and each time I voided I would empty the bottle and fill it again from myself. I carried this out for 24 hours, day and night.

The next morning I cultured the bottle again. If the bottle were acting as a bladder and residual urine were eliminated, since I allowed the last drop to come out of the bottle, although it was not dry and air did not enter it, then one would assume that the bottle would be sterile. If, on the other hand, there is a protective mechanism in the bladder, I would have it and the bottle would not.

The culture count the next morning was 2×10^4, the same count that I started with.

What does this mean? It means that there are three kinds of bladders. We have the normal person in whom you can introduce bacteria. He has no residual urine and has a normal protective mechanism. He will get rid of the bacteria.

The second group of patients with whom we are all familiar have a normal protective mechanism but they have residual urine. They get cystitis, white blood cells, and so on. They get an infection.

The third group is that with apyuric bacilluria in whom the urine is loaded with bacilli and yet you can find no obstructive element. These must fit into the third group. The protective mechanism has been abolished and these patients then carry bacteria symbiotically.

If we can carry this thinking into the catheter problem, then I think we can separate our patients into these groups and can stop trying to find this last infinite area of residual urine, which probably doesn't exist, since we all carry some residual urine.

DR. MYRON H. NOURSE (Indianapolis, Ind.): I appreciate the discussion of this controversial subject. I would like to comment on the important findings mentioned by Dr. Vermeulen concerning the rat bladder.

When I read the article he mentions, the question arose, "Maybe this is normal for the rat, and there is reflux routinely." Certainly the fact that it was a uniform and regular finding seemed that

it must be part of the normal physiology of the rat's bladder.

Dr. Vermeulen's work on this subject is a valuable contribution.

DR. B. MARVIN HARVARD (New Haven, Conn.): Before I talk about fungi I would like to second our President's views on the pyelonephritis question.

The thing that is most important, I think, is the fact that we have been forced to review our behavior critically, and for that I am grateful.

The other point is that criticism in the current controversy is not directed so much at urologists per se and their use of instruments, but at their lack of evangelism, if you will, in teaching the proper use of these instruments and making all who have access to their use understand that such instrumentations are surgical procedures. As you all know, simple catheterization should be carried out under the strictest surgical technique. Criticism is directed at the misuse of the catheter by those who do not respect this fact.

I have been asked about propionate jelly. I use one sold under the trade name Propion Gel. It is inexpensive and simple to use. I have not used the antibiotic fungicides.

I think perhaps we are going to see more manifestations of this problem. This is but one small facet of it. In a perusal of the current literature one finds more and more very serious lesions being reported.

INTRATUBULAR BODIES OF THE HUMAN TESTIS

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In the embryo the sexually bipotential gonad becomes either a testis or ovary dependent upon the chromosomal constitution of the individual, i.e. a sex chromosomal pattern of XY induces testicular differentiation and a pattern of XX results in ovarian development. At the present time it is believed the gonads exert an influence on the müllerian and wolffian ducts through local acting organizers or inductors and the evidence is most convincing for the embryonic testis.[1]

Abnormal genetic factors representing disturbance in chromosomal constitutions may produce dysgenetic gonads. A dysgenetic gonad may fail to exert any inductor (testis) influence or develop this ability so late that the müllerian or wolffian tract is no longer responsive. In clinical cases dysgenetic gonads are often accompanied by abnormalities of the genital duct systems. A rather normal expectation would be the detection of remnants of bisexual gonadal tissue in the dysgenetic testes of sexually immature young patients. It is the purpose of this essay to direct particular attention to this possibility. A review of several previously reported cases will stress one testicular histologic lesion, the intratubular body found within the seminiferous tubules of dysgenetic gonads in young patients. It is proposed that these bodies are oocytes and represent persistence of bisexual gonadal elements.

DEFINITION

Occurrence. We have seen the bodies only in the prepubertal dysgenetic testis or an ovotestis. These gonads were from patients with nondescent of the testis, malformed genitalia or aberrant duct systems. Dysgenesis is evident from a diminution in the tubular size, reduction in the number of germinal cells, germinal cell aplasia, retarded maturation of the germinal epithelium and groups of abnormal tubules in the tunica albuginea.

Histology. The intratubular bodies vary in diameter from 30 to 120 mm. and occur in dilated portions of seminiferous tubules (120–180 mm.). Serial sections have established that the containing tubule is continuous and resumes a diameter approximating those of surrounding tubules once the area of the intratubular body is passed. At times a tangential cross-section through the basement membrane of a tubule will present a deceptive appearance of such a body, but this artifact is much smaller and continuity within a tubule can not be established. Sustentacular cells are arranged in two distinct layers. The outer one lying against the basement membrane has elongated nuclei, the nucleoli are often multiple, the chromatin material is granular and the cytoplasm is extended towards the interior of the tubule. The inner layer is composed of a lesser number of similar cells with their nuclei applied closely to the central core. The cytoplasm of these cells seems at times to blend with those of the outer layer. An occasional cell will be found betwixt the two cellular layers. A central core of suspected nuclear origin may be surrounded with concentric rings of material, the outer zone of which stains intensely with Mallory's trichrome stain and lightly with eosin. The nuclear area stains diffusely with hemotoxylin, intensely with periodic acid, Schiff (PAS) and exhibits metachromasia with toluidine blue.

CASE ABSTRACTS

M. K., a 5-year-old patient, was found to have bilateral undescended ovotestes. Figure 1, *A* demonstrates an ovotestis with oocytes within seminiferous tubules. Figure 1, *B* depicts a degenerating oocyte within a seminiferous tubule and the histologic configuration of the central body with two layers of sustentacular cells is depicted.

S. T., aged 6 years, was a case of gonadal

[1] Jost, A.: Problems of fetal endocrinology: The gonadal and hypophyseal hormones. Recent Progr. Hormone Res., 8: 379–418, 1953.

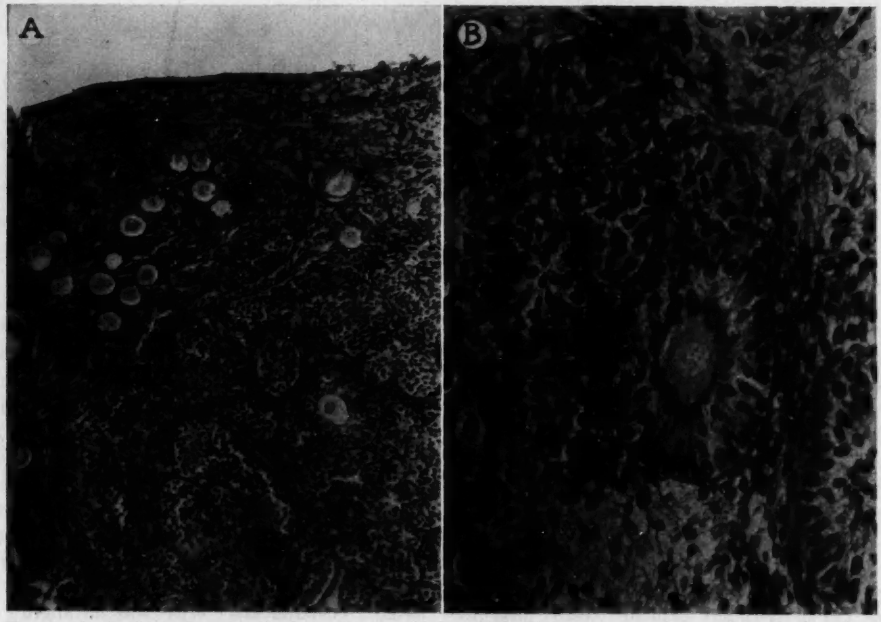

FIG. 1. *A*, section of ovotestis from 5-year-old boy (M. K.) shows ovarian and testicular tissues. Note oocyte within seminiferous tubule at lower right. *B*, same patient as *A*. Note degenerating oocyte within seminiferous tubule, double layer of sustentacular cells and nuclear degeneration of oocyte. Spermatogonium is present in outer layer.

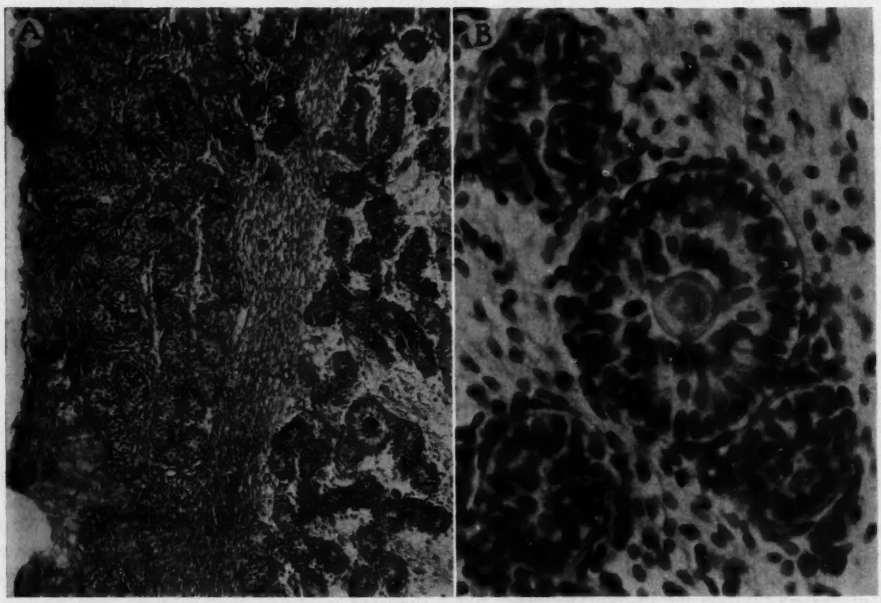

FIG. 2. *A*, S. T., 6-year-old child with left fallopian tube and undifferentiated testis; undescended right testis with wolffian structures. Note area within tunica albuginea containing dysgenetic seminiferous tubules, particularly doughnut shape of one in upper left position. Bizarre shaped germinal cells are present. Lower right is intratubular body within continuous seminiferous tubule. *B*, same case as *A*. Note intratubular body from another section of right dysgenetic testis.

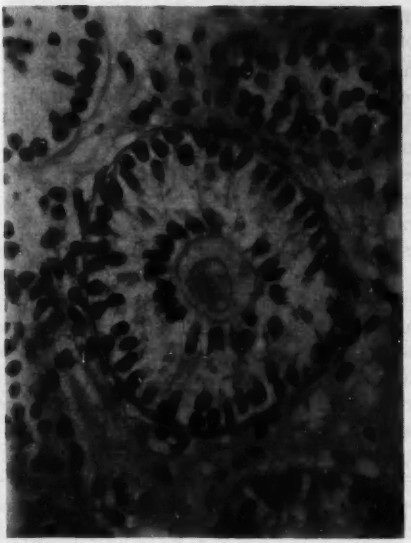

FIG. 3. D. B., a 10-year-old boy with positive chromatin test. Bilateral testicular material revealed areas of dysgenesis and intratubular bodies, one of which is depicted. H & E stain.

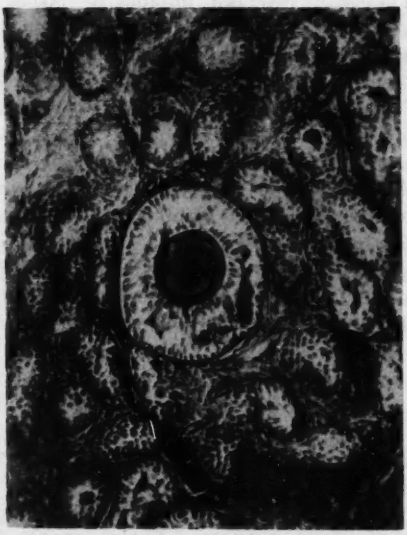

FIG. 4. D. H., 4-year-old boy with hypertelorism, precocious germinal epithelium in descended left testis, reduplication of right great toe and undescended right testis. Right testis contained intratubular bodies as depicted and other histologic evidence of dysgenesis. Mallory's trichrome stain.

FIG. 5. B. P., 6-year-old boy, had similar set of findings as H. D. (fig. 4), i.e., hypertelorism, precocious germinal epithelium in descended left testis, reduplication of right thumb and undescended right testis. In undescended testis, areas of dysgenesis and intratubular bodies were found. H & E stain.

dysgenesis with a fallopian tube and undifferentiated gonad and an undescended testis. The latter showed areas of dysgenesis particularly in the tunica albuginea (fig. 2, *A*). An intratubular body (described above) is depicted in figure 2, *B*.

D. B., aged 10 years, a slightly taller than normal boy, was found to have a chromatin positive test and whose subsequent testicular biopsies revealed the presence of intratubular bodies depicted in figure 3.

D. H., aged 4 years, had hypertelorism, precocious germinal epithelium in the descended testis; reduplication of the right great toe and undescended right testis. The latter showed areas of dysgenesis including intratubular bodies depicted in figure 4.

B. P., aged 6 years, had a similar set of findings, i.e. hypertelorism, precocious germinal epithelium in the descended left testis, reduplication of the right thumb and a dysgenetic right undescended testis. Figure 5 depicts an intratubular body within the right testis.

DISCUSSION

Oocytes within seminiferous tubules have been described in sexually immature animals[2-4] and the first case presented in our series demonstrates that they can likewise occur in human material. Our particular interest was directed towards those degenerating oocytes which had the two-layered sustentacular cellular response. It was noted, however, that where the oocytes were well preserved, the tubular diameter was much increased and we were unable to detect from the microscopic preparations whether the oocytes were traveling along the tubule in which they were found and what initiated the sustentacular response. It might be postulated that the oocyte being a larger cell and requiring more nourishment than could be obtained by diffusion in its central location of the tubule, degenerated gradually. Further residence in the tubule and the demands of other cells at puberty may well cause its eventual death and disappearance, thus explaining its absence from postpubertal testes.

Abnormal genetic factors are undoubtedly responsible for the anomalies and dysgenesis occurring in the gonads of the patients just reviewed. The discovery that patients with the Klinefelter's syndrome were chromatin positive gave further indication that an abnormal genetic factor was likely the responsible agent. Subsequent studies have shown that the chromosomal constitution of such patients is an XXY. This clarified the confusion which was momentarily generated when it was also discovered by examination of serial sections of the testes, that although most of the seminiferous tubules were hyalinized or contained only sustentacular elements, some could be found which contained spermatogenesis.[5] The discovery of a prepubertal boy whose chromatin test was positive[6] afforded an opportunity to study a patient who might develop the Klinefelter's syndrome in later life. A testicular biopsy revealed not the degeneration as exhibited in the postpubertal Klinefelter testis but abundant seminiferous tubules, some sterile, while others contained germinal cells. We were impressed by the resemblance of the intratubular bodies found in these testes to those of degenerating oocytes in an ovotestis. The case of the 6-year-old boy with a fallopian tube and undifferentiated testis and the contralateral dysgenetic testis with the intratubular bodies caused further interest. Here the bodies were accompanied by abnormal tubules in the tunica albuginea, an anatomical area related to the primitive cortex. In the last 2 cases evidence of dysgenesis in the testicles is represented by the intratubular bodies.

Several types of intratubular bodies have been described in prepubertal and adult testes, usually in association with dysgenesis. Our present observations are concerned with the type mentioned above, i.e., a central core with two layers of sustentacular cells occurring in a continuous seminiferous tubule of a prepubertal testis. Blumensaat[7] described intratubular bodies in six prepubertal testes out of a total of 52 studied. Only one of his published illustrations seems to fit our description. The published illustrations of Crewe,[8] of Sohval,[9] and those of Sniffen[10] may represent another type of abnormality. Because of the striking resemblance of the intratubular bodies to those seen in the ovotestis, the authors propose as a working hypothesis that these bodies in dysgenetic testes are oocytes and represent cortical tendencies from a primitive gonad. The concept of the authors that the Klinefelter's syndrome represents the adult form of a true intersex[6] would be strengthened if tissue were available for examination from chromatin positive male infants. It seems quite

[2] Krediet, G.: Übergangsformen zwischen Follikeln und Semenkanalchen in einem Ovariotestis. Ztschr. f. d. ges. Anat., **101:** 228, 1933.

[3] Brambell, F. W. R.: The histology of an hermaphrodite pig and its developmental significance. J. Anat., **63:** 397, 1929.

[4] Bradbury, J. T. and Bunge, R. G.: Oocytes in seminiferous tubules. J. Fertil. & Steril., **9:** 18, 1958.

[5] Bunge, R. G. and Bradbury, J. T.: Newer concepts of Klinefelter syndrome. J. Urol., **76:** 758, 1956.

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[7] Blumensaat, C.: Über einen Befund in Knabenhoden. Virchows Arch. f. path. Anat., **273:** 50, 1929.

[8] Crewe, F. A. E. and Fell, H. B.: Nature of certain ovum-like bodies found in seminiferous tubules. Quart. J. Microscopical Sc., **66:** 557–578, 1922.

[9] Sohval, A.: Histopathology of cryptorchidism. Am. J. Med., **16:** 346–362, 1954.

[10] Sniffen, R.: The testis. I. The normal testis. Arch. Path., **50:** 259–284, 1950.

likely that oocytes will be found within seminiferous tubules in such individuals.

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DISCUSSION

DR. ROBERT S. HOTCHKISS (640 Park Ave., New York, N. Y.): Did you make chromosome counts along with these observations?

DR. RAYMOND G. BUNGE (Iowa City, Iowa): No, we haven't made any chromosomal counts, although they have been made in cases of the Klinefelter syndrome by other people.

DR. JOSEPH H. KIEFER (Chicago, Ill.): I don't have anything to add to what Dr. Bunge said. He showed me one of his slides six months or a year ago. We haven't had a chance to review our slides, but his work leads one to some flights of fancy.

Consider that these intratubular inclusion bodies occur in that group of testes; the dysgenetic, undescended testes, in which tumors have a greatly increased incidence, 40 to 50 times normal. I think we will have to get out our testis tumors and start looking for these bodies in the uninvolved portions of them. It could be a possible source for this tumor which is pretty generally acknowledged to be an embryoma.

PERFUSION OF THE PELVIC AND PROSTATIC CIRCULATION WITH CANCER CHEMOTHERAPEUTIC AGENTS: INTRA-ARTERIAL INJECTION AND EXTRACORPOREAL REGIONAL PERFUSION

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Since the initial description[1] in 1941, of chemotherapy by means of estrogens for prostatic cancer, the familiar palliative effects described therein have remained the standard of therapy. Subsequent additions of treatment modalities, including interstitial local injection of antitumor agents, have not gained wide acceptance. In spite of long remission, treatment remains essentially palliative in the patient whose cancer is too advanced for surgical care. A similar situation obtains in bladder cancer with local extension beyond the bounds of cystectomy. Newer chemotherapeutic agents and recent innovations in therapy have not undergone extensive clinical trials in the treatment of these two common urological malignancies.

Our study was undertaken to determine whether it might be feasible to isolate the prostatic and pelvic circulations in such a manner as to present higher concentrations of chemotherapeutic agents to the tumor than would be possible if these agents were administered systemically. This has been done in two ways, by intra-arterial injection of the perfusing material and by regional perfusion of the isolated pelvic circulation utilizing an extracorporeal circuit. Actinomycin D and 5-fluorouracil (5-FU), were selected for experimental and clinical trial as antitumor agents.*

The direct introduction of an antitumor agent into the arterial supply of a tumor bearing area was initiated by Klopp and associates[2] in 1950 when nitrogen mustard was administered in this manner in single or fractionated dosages. Although this was more effective than systemic use, it was still limited by systemic toxicity. The risk of damage to the hematopoietic and gastrointestinal systems precluded the use of these agents in dosages high enough to be curative until the report of Creech and associates in 1958.[3] These authors found that a tumor bearing area might be temporarily isolated and perfused with maximal amounts of an antitumor agent by means of an extracorporeal circuit. Phenylalanine mustard could be supplied to an isolated extremity in concentrations forty times the amount which could be tolerated by the entire animal. Subsequent reports by this group,[4,5] and Stehlin and associates,[6,7] have indicated that this form of treatment is most useful in malignant melanoma of the extremities. Treatment of other sarcomas and of carcinoma has been less effective. Use of this method for treatment of prostatic or bladder cancer has not been described.

While perfusion of an extremity is an ideal situation in that its circulation can be totally excluded from the systemic circulation, the exclusion of the pelvic circulation is a much more difficult undertaking. The many vascular

* Anti-tumor agents were supplied by the Cancer Chemotherapy National Service Center, National Cancer Institute, National Institutes of Health, Bethesda, Md.

[1] Huggins, C. and Hodges, C. V.: Studies on prostatic cancer: I. The effect of castration, of estrogen and of androgen injection on serum phosphatases in metastatic carcinoma of the prostate. Cancer Research, **1:** 293, 1941.

[2] Klopp, C. T., Batemna, J., Berry, N., Alford, C. and Winship, T.: Fractionated regional cancer chemotherapy. Cancer Res., **10:** 229, 1950.

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[4] Creech, O., Jr., Ryan, R. F. and Krementz, E. T.: Perfusion technique. J. A. M. A., **169:** 339–343, 1959.

[5] Creech, O., Jr., Krementz, E. T., Ryan, R. F., Reemtsma, K. and Elliot, J. L.: Perfusion treatment of patients with cancer. J. A. M. A., **171:** 2069–2075, 1959.

[6] Stehlin, J. S., Jr., Clark, R. L., Jr., Smith, J. L., Jr. and White, E. C.: Malignant melanoma of the extremities: Experiences with conventional therapy; a new surgical and chemotherapeutic approach with regional perfusion. Cancer, **13:** 55–66, 1960.

[7] Stehlin, J. S., Jr., Clark, R. L., Jr., White, E. C., Smith, J. L., Jr., Griffin, A. C., Jesse, R. H., Jr. and Healey, J. E., Jr.: Regional chemotherapy for cancer: Experiences with 116 perfusions. Ann. Surg., **151:** 605–619, 1960.

anastomoses normally present, along with those induced by a large tumor, make leakage of the perfusing agent an extremely serious risk to the organism, particularly by interference with hematopoiesis. The most severe effects are thrombocytopenia and leukopenia; these changes are usually noted in about 7 days, and become most severe in 10 days following perfusion. It has been difficult to document a reduction in erythrocyte count in our patients because of concomitant urinary bleeding. However, it has been reported by other authors.[5] Vascular thrombosis would be expected as a result of injury due to cannulation and the administration of irritating agents, but the incidence has been surprisingly low in all reported series. Palliative effects generally found in those patients in whom there was sufficient survival for evaluation have been shrinkage in tumor mass, relief of pain, and occasionally the transformation of a nonresectable lesion into a resectable one.

METHODS AND MATERIALS

Experimental. Dissection and perfusion of the isolated prostatic circulation in the dog were done, as described previously, by Behnam and Ocker.[8] The prostatic circulation is isolated. The femoral artery and vein of one leg are cannulated to allow insertion of the cannulating catheters up to the level of the bifurcation of the aorta and vena cava. The cannulae are connected to a pump-oxygenator circuit and perfusion carried out. From experience gained by perfusion of about 100 dogs with other compounds, we know that perfusion in itself for periods of 30 minutes results in no discernible damage to the prostate nor to other organ systems, and that dogs survive without complication. In these previous studies, isolation of the prostatic circulation was virtually complete as shown by failure of radioactive perfusing materials to appear in the systemic circulation. To resemble, to an unpredictable degree, the incomplete isolation of the pelvic circulation in the human, the parietal branch of the internal pudic artery in the dog was not ligated in the studies described below.

Adult mongrel male dogs were used. The prostatic circulations of five controls were perfused with ACD blood alone. There was no hematopoietic depression or other evidence of ill effect from the control procedure.

Ten dogs were perfused in the manner similar to that just described, using varying dosages of actinomycin D, to determine the toxicity of the material at various dosage levels and to study the effects of actinomycin D on the prostate gland and other organ systems.

Actinomycin D, an antibiotic, has been shown to possess considerable cytotoxic effect.[9] The response is directly related to the tissue source. In clinical use it has been most effective against Wilms tumor; clinical responses have been reported in a variety of other tumors, most of which are nonepithelial in origin.

The prostatic circulations of 6 dogs were perfused with blood containing actinomycin D, 75 gamma per kilogram of body weight. Four dogs died of massive hemorrhage, both intra-abdominal and incisional, possibly from over-heparinization. One dog showed, in addition, bilateral complete atelectasis. The fifth dog died on the fourth postoperative day of undetermined causes. The sixth dog died on the sixth postoperative day with wound dehiscence, evisceration and acute gastric dilatation.

The dosage was reduced to 45 gamma per kilogram of body weight and the prostatic circulations of an additional four dogs were perfused. Systemic heparinization was avoided. All dogs survived. Three are still under observation at 6–8 weeks, for late effects on the hematopoietic and other systems. One dog showed marked reduction of the thrombocyte count on the thirteenth postoperative day. There was a quick return to normal. The other two survivors showed no evidence of toxicity. The animal sacrificed at 2 weeks showed no histologic change. There was no evidence of necrosis or other damage in the prostate gland or other organs. Bone marrow smears were normal.

5-Fluorouracil, an antimetabolite, has been reported to be effective when given systemically in palliation of bladder cancer; Deren and Wilson[10] found an early remission rate in 7 out of 10 patients.

The prostatic circulations of 2 dogs were perfused, employing 5-fluorouracil as the perfusing agent in a concentration of 20 mg./kg

[8] Behnam, A. M. and Ocker, J.: Perfusion of the isolated prostatic circulation with radioactive phosphorus (P-32). J. Urol., **84:** 753–757, 1960.

[9] Cancer chemotherapy reports, **5:** 53–59, 1959.

[10] Deren, T. L. and Wilson, W. L.: Use of 5-fluorouracil in treatment of bladder carcinoma. J. Urol., **83:** 390–393, 1960.

body weight. One dog died in 36 hours from postoperative bleeding. The other survived without evidence of damage to the hematopoietic or other systems.

EXTRACORPOREAL PERFUSION OF THE PELVIC CIRCULATION IN HUMAN PATIENTS WITH PROSTATIC OR BLADDER NEOPLASM, USING ACTINOMYCIN D

During the period from January 23, 1959 to December 1, 1959, three male patients with sarcoma of the prostate gland, carcinoma of the bladder, and adenocarcinoma of the prostate gland respectively, were perfused with actinomycin D, employing an extracorporeal perfusion apparatus. A description of the technique, followed by the case history of each patient is presented.

Technique. Under general anesthesia and with the patient in the supine position, the abdomen is prepared with a detergent antiseptic and draped. A midline incision is made from the pubis to above the umbilicus. The peritoneal cavity is entered and complete intra-abdominal exploration carried out to determine the choice between surgical extirpation and perfusion. If the tumor is not surgically curable, the posterior parietal peritoneum overlying the aorta and inferior vena cava in their terminal portions, the common iliac, and hypogastric and external iliac vessels are freed of surrounding tissue. Tapes are passed above and below the area selected for entrance into the common iliac arteries on either side. (It was found easier to cannulate each common iliac artery and pass a size 18 Bardic catheter distally into the hypogastric artery, utilizing two common iliac cannulations rather than a single aortic cannulation.) The femoral artery and vein on either side are isolated and secured with bulldog clamps or tapes. Tapes are placed around the vena cava, approximately 2 cm. and 4 cm. above its bifurcation. Between these tapes, the vena cava is opened and a size 18 Bardic plastic catheter is introduced and directed distally until its tip lies at the bifurcation of the inferior vena cava. The lower tape is tightened around the vena cava sufficiently to prevent leakage.

Prior to cannulation of the vessels the patient is heparinized, using 2 mg./kg. body weight. The single sigma motor pump is primed with heparinized bank blood. (Oxygenation was not employed in perfusion of these 3 patients, although it has definite advantages as described later.) Perfusion of the pelvic circulation is carried out, utilizing a flow rate of 100 to 150 cc per minute, and an arterial pressure of approximately 110 mm. of mercury, for 30 to 40 minutes. Five minutes before the conclusion of the perfusion, Evans blue dye is injected into the extracorporeal circuit. Five minutes later, samples of blood from the extracorporeal circuit and from the systemic circulation are drawn to calculate the amount of leakage. A pelvic roentgenogram is made after injection of 60 ml. 50 per cent hypaque to show the extent of perfusion.

The cannulation sites in the inferior vena cava and the common iliac arteries are repaired with a running suture of closely spaced 00000 atraumatic arterial suture. If considerable oozing persists, protamine sulfate is administered intravenously. The posterior and anterior parietal peritoneal layers are closed, using running sutures of 00 atraumatic chromic catgut. Retention sutures of size 28 stainless steel wire are placed. The rectus fascia is closed with interrupted silk or wire sutures. The skin is closed with silk or wire. A nasogastric tube and a urethral catheter are placed. The average total operating time is 5 hours. The average estimated blood loss is 3,000 ml.

Case reports. Case 1: L. J., No. 23-26-66, a 57-year-old white man, was admitted to the University of Oregon Medical School Hospital on January 3, 1959. He exhibited a huge prostatic mass with urinary retention due to encroachment on the urethra. Perineal needle biopsy disclosed a prostatic sarcoma. Approximately 300 cc thick yellowish liquid material was aspirated from the center of the prostatic mass, indicating necrotic breakdown of the central portions of the tumor. At operation on January 23, 1959, large tumor masses were found in the liver. The primary tumor entirely filled the bony pelvis. Perfusion was carried out, using actinomycin D, approximately 80 gamma per kilogram. Fifty per cent leakage into the systemic circulation was estimated by the Evans blue technique. Total perfusion time, 35 minutes.

In the postperfusion period no hematologic depression was noted. Serial transperineal needle biopsies consistently showed necrosis but it was impossible to state that there was a quantitative progression of necrosis. Bleeding persisted from the urinary bladder and necessitated bilateral hypogastric artery ligation on the seventh day.

At this intervention, it was found that the portion of bladder wall next to the peritoneal surface, heavily infiltrated with tumor, had undergone necrosis and there was, in effect, an intraperitoneal rupture of the urinary bladder. This was repaired and a cystostomy tube placed. The patient died on the tenth day after perfusion. Autopsy showed bronchopneumonia, left adrenal hemorrhage and extensive metastases to the liver. The primary tumor showed considerable necrosis but many areas of viable tumor were also present.

Case 2: D. M., No. 26-53-07. A 54-year-old white man entered the University of Oregon Medical School Hospital on February 2, 1959 complaining of painless hematuria. Examination revealed a massive bladder tumor with extensive fixation to the right wall of the bony pelvis. Biopsy showed undifferentiated carcinoma of the bladder, histologic grade 4. Excretory urography showed moderate right hydronephrosis and hydroureter. Extracorporeal perfusion was carried out on February 17, 1959, using actinomycin D, 60 gamma per kilogram of body weight. Perfusion lasted 40 minutes. The patient did well in the early postoperative period. On the thirteenth day after perfusion, his white count reached a low of 1,700 with only 5 per cent neutrophils and 87 per cent lymphocytes. The wire retention sutures were removed on the thirteenth postoperative day, following which prompt wound dehiscence and evisceration occurred. There appeared to be almost no wound healing. At the time of reclosure of the abdomen it appeared that the tumor had grown visibly since the time of perfusion. The patient again did well. Excretory urography on March 10, 1959 now showed no visualization of the right upper urinary tract and early hydronephrosis and hydroureter on the left. A transurethral resection of the tumor for biopsy purposes was carried out on the same day. Pathologic report was grade 4 carcinoma, showing no change from the preperfusion specimens.

On March 17, 1959 actinomycin D, 5 mg., was injected into the right common iliac artery through a catheter introduced percutaneously into the right femoral artery. This was tolerated without incident and the patient was discharged March 22, 1959, to return to the care of his own urologist. There was no further evidence of hematopoietic depression and he died June 5, 1959 of uremia and cachexia from extensive metastases.

Case 3: W. T., No. 27-51-16. A 71-year-old white man was admitted to the University of Oregon Medical School Hospital on November 17, 1959. Examination revealed a huge tumor occupying the entire pelvis. Perineal needle biopsy confirmed the previous diagnosis of adenocarcinoma of the prostate gland. The testes were absent. The right kidney had been removed surgically some years previously. The left renal system was normal. Extracorporeal pelvic perfusion was carried out on December 1, 1959 using actinomycin D, approximately 80 gamma per kilogram. Perfusion time was 20 minutes. There was extensive loss of the perfusing material into the systemic vascular circuit. The patient exhibited periods of hypotension during the first 4 days of the postoperative period. He then appeared to improve markedly. Bowel sounds returned early. On the ninth postoperative day he became hypotensive and then bilateral bronchopneumonia developed. On the tenth day after perfusion, his white blood count was 1,081 with only 8 per cent neutrophils. He failed rapidly and died December 11, 1959. Autopsy showed a huge primary prostatic carcinoma with extensive local and metastatic involvement, bilateral atelectasis and bronchopneumonia and three minute gastric "stress" ulcers. The perfusion had not effected significant tumor necrosis.

INTRA-ARTERIAL INJECTION OF THE PELVIC CIRCULATION USING 5-FLUOROURACIL

Four patients were treated with 5-FU by intra-arterial injection of the tumor site. This group consisted of two males and two females, average age 72 years. Three had far advanced transitional carcinoma of the bladder with extensive soft tissue metastases. The fourth showed adenocarcinoma of the prostate with metastases involving the soft tissue surrounding the prostate, extension into the shaft of the penis, and metastases to the lumbar vertebra.

Technique. Dosage of 5-FU is calculated at 20 mg./kg. body weight. Under local anesthesia, a size 14 gauge needle is inserted percutaneously into the right femoral artery. The obturator is withdrawn and a flexible metal stilette guided into the femoral artery and up to the aortic bifurcation. The needle is withdrawn leaving the stilette in place. A size 15 gauge polyethylene catheter is then threaded over the metal stilette and up the femoral artery to the aortic bifurcation. The position is checked by x-ray. The metal

stilette is withdrawn and the polyethylene catheter connected to a syringe containing 10 cc normal saline, 5 mg. heparin, and 1 cc of 1 per cent procaine. Tourniquets are applied to the thighs and the circulation in the legs is stopped by inflating the cuffs to 20 millimeters of mercury above the patient's systolic blood pressure. The 5-FU solution is slowly injected through the polyethylene catheter at the level of the aortic bifurcation. The tourniquets are left, inflated, for 5 minutes. The polyethylene catheter is withdrawn and a tight compression dressing applied to the thigh.

Results. Of the 4 patients who received 5-FU by this technique, two showed both subjective and objective improvement, consisting of disappearance of edema of the lower extremities, decrease in size of the palpable pelvic tumor, increase in appetite and weight, and decrease in pelvic pain. The prostatic cancer was not affected.

There was one major complication, thrombotic occlusion of the right superficial femoral artery 3 days after injection of 5-FU. A thrombectomy was accomplished at this site with good restoration of a popliteal pulse; pulses in the lower extremity were never restored. The leg became ischemic but did not require amputation.

Three patients who received 5-FU died within two months of their injections. Deaths were due to metastatic disease. One patient is still living 4½ months after the injection of 5-FU and has maintained subjective improvement.

Discussion. The results in the first group of 3 patients with their fairly representative group of lesions, that is, prostatic sarcoma, prostatic cancer, and bladder cancer, were quite disappointing. In spite of exposure of the tumor bearing area to relatively high dosages of actinomycin D, there was no evidence of objective remission and no claim to palliation.

It is appropriate to wonder why perfusion of the pelvic circulation in these instances has not been as effective as perfusion of the extremities. First, it is impossible to isolate the pelvic circulation as completely as that of the extremities. Austen and associates[11] have reported leakage of as high as 50 per cent to 75 per cent of the perfusing material. This is a result of the many vascular anastomoses. In our cases it was even more difficult, because of the large size of the tumors which completely filled the pelves, to control the anastomotic branches, particularly the posterior divisions of the hypogastric arteries; this undoubtedly represented a considerable portion of the leakage.

Second, oxygenation of the perfusing system might well have improved antitumor effect. Favorable response of tumor to x-ray and to antitumor agents is potentiated by a high oxygen tension. At the present time plastic disposable oxygenators are available and will be used in future perfusions.

Third, the choice of antitumor agent may be extremely important. This brief study indicated the possibility that 5-FU, even when employed by a less favorable technique, was more effective than actinomycin D. It will be desirable to conduct systematic pilot studies of all known antitumor agents in similar clinical situations to select suitable agents for further trial. Alternatively, Golomb and associates[12] advocate basing the choice of the agent on tests in which the patient's tumor is exposed in tissue culture to a spectrum of antitumor agents prior to perfusion.

Complications noted in the patients perfused with actinomycin D included hematopoietic depression, impaired wound healing, increased susceptibility to infection (bronchopneumonia) and superficial ulceration of the gastric mucosa. All are considered to be due to the extensive leakage of perfusing material from the pelvic vascular system into the general circulation. Useful application of this technique in patients with prostatic or bladder cancers will depend upon refinements directed toward more effective isolation of the tumor vascular bed.

Two out of 3 patients with bladder cancer treated by single intra-arterial injection of 5-FU showed objective tumor regression and subjective improvement. The single major complication, thrombotic arterial occlusion below the site of injection, may have been the result of high concentration of 5-FU or of too rapid injection. Further trials, perfusing the isolated pelvic circulation in patients with bladder cancer, are warranted.

[11] Austen, W. G., Monaco, A. P., Richardson, G. S., Baker, W. H., Shaw, R. S. and Raker, J. W.: Treatment of malignant pelvic tumors by extracorporeal perfusion with chemotherapeutic agents. New Eng. J. Med., **261:** 1037–1045, 1959.

[12] Golomb, F. M., Wright, J. C., Cobb, J. P., Gumport, S. L., Postel, A. and Safadi, D.: The chemotherapy of human solid tumors by perfusion technics (abstract). Proc. Am. Assoc. Cancer Res., **3:** 114, 1960.

While our studies were made in near terminal patients in whom there was no hope of cure and little of palliation, but made primarily to gain information regarding antitumor effect, further evaluation should more ideally be carried out in patients whose cancer had advanced too far for radical surgery, but in whom there is the prospect of cure or perhaps of modification by antitumor agent to the point where surgical excision could be considered.

No "prostatorhexic" effect was noted in our perfusions of the dog prostates with the antitumor agents. Further trials with higher dosages are in progress in an attempt to find agents that will affect the normal prostate. Such screening tests might be useful as a preliminary to trials of these agents in prostatic cancer, since prostatic cancer cells and normal prostatic epithelial cells share many responses in common.

SUMMARY AND CONCLUSIONS

Seven terminal patients with prostatic or bladder cancer were treated either by perfusion of the isolated pelvic circulation, utilizing extracorporeal apparatus, or by direct intra-arterial injection of antitumor agents. The agents selected were actinomycin D and 5-fluorouracil. No beneficial effects were noted with actinomycin D. Palliative effects were noted in two out of 4 patients in whom 5-fluorouracil was used. Further studies, using more refined techniques, varied dosages and running the spectrum of antitumor agents, are indicated to ascertain whether regional chemotherapy has any promise in these areas of urologic malignancy.

DISCUSSION

Dr. Henry Weyrauch (San Francisco, Cal.): If I had any apology to offer for not discussing pyelonephritis this morning, I think the reason was that I thought our august body was making the same mistake that was made in the United States Congress a few years ago. You will recall when all the men were ganging up on Margaret Chase Smith with ineffectual debate, Senator Everett Dirksen of Illinois arose and said: "Gentlemen, there is no use of further discussion. All we are doing is beating an old bag of bones."

I wondered this morning whether we weren't beating the old bag of bones of pyelonephritis. We received some favorable publicity from medical men bringing up the subject again, and certainly we are getting back the urethral catheter, which is good, but we are not doing much more for the patient now than we were doing twenty years ago.

With chemotherapy, we have something in which strides in therapy are being made. As Dr. Hodges mentioned, it is a field which we have barely launched.

My interest in chemotherapy was around a few years ago in cancer of the prostate, using a drug that proved successful in other fields, triethylene thiophosphoramide or thio-TEPA. We found it did well in about 50 per cent of selected cases of disseminated prostatic carcinoma.

I attacked the problem much like Dr. Hodges, and it was not as difficult. We first resected the carcinoma of the prostate as close as we could to the capsule, and then we used a flexible needle to inject thio-TEPA directly into the remaining prostatic cortex.

This appeared much easier than perfusion, although I had not heard of perfusion at that time, and later I speculated whether if we were to just inject the drug intravenously it might be as efficacious. So, as part of our experiments we injected a radiopaque preparation, mixing thio-TEPA with 40 per cent skiodan, and we found that it entered the iliac vessels and aorta in about 15 minutes' time and was all dissipated from the prostate.

This raised the question whether this alkylating agent could produce any greater concentration or would do any more good by injection into the prostate. As we have continued using it, we have had such excellent results with intravenous injection that I think we should run double blind experiments to see whether it is better to give it intravenously or to inject it into the prostatic cortex.

Another important thing that has been brought up this morning is the theory of a multiple attack. In treating carcinoma of the prostate as well as other tumors we can sometimes reduce the resistance of carcinomatous cells with one agent and then hit them hard with another. I think glandular ablations are sometimes indicated, certainly with orchiectomy. Steroids are good. Then we have chemotherapy, which is an added agent.

In bladder carcinomas we also have a few good results with 5-fluorouracil, and it appears we may attain even better results by combining 5-fluorouracil with x-ray.

There is another area in cancer therapy which we are just about to explore, and I am glad to see a few publications appearing in our urologic literature about covering the patient with chemotherapeutic agents during radical or so-called radical operations for urogenital neoplasms, as was introduced in general surgery by Warren Cole.

Dr. William P. Herbst, Jr. (Washington, D. C.): I should like to comment on another aspect of the utilization of these chemical agents, specifically thio-TEPA.

It has been shown that malignant cells are recoverable by collecting blood from the region where malignancies exist. It has been demonstrated that handling these malignancies increases the number of malignant cells circulating in the region.

That being true, it would seem that there should certainly be no objection to utilizing a principle of injecting thio-TEPA, maybe 45 mg. intravenously, before, during or after surgery, being meticulously careful in the handling of the tumor.

STRESS INCONTINENCE

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The urinary sphincter has been found to be a tubular structure synonymous with the proximal three-fourths of the female urethra or the prostatic and membranous portions of the male urethra; in both male and female these segments of urethra are actually the true bladder necks. The wall of the urethra contains much elastic tissue in addition to smooth muscle. The urinary sphincter maintains continence by virtue of the resistance its apposing walls present to fluid pressure. The elastic and muscle fibers in the urethral wall keep the lumen of the urethra narrow without the aid of motor impulses from the central nervous system.

When intravesical pressure is markedly elevated by exertion, urethral resistance must be increased to prevent urinary incontinence. In the normal male and female human this is accomplished by a two-fold action of the striated muscle of the urogenital diaphragm and pelvic floor. These muscles compress the urethra or urinary sphincter circumferentially as well as elongate it by pulling it cephalad toward the fundus. The net result of the striped muscle activity is to decrease the caliber of the urethral lumen, to increase the tension of the urethral walls against its lumen and to increase the length of the urethra—all factors which increase the resistance of the urinary sphincter to the flow of fluid through it.

Studies in normal women reveal that the urinary sphincter or urethra is a mobile structure whose length varies with type of activity. A young, nulliparous woman under spinal anesthesia may demonstrate a urethral length of 3.8 cm. If she is perfectly relaxed in the supine position, the urethral length will still be 3.8 cm. without anesthesia. Voluntary contraction of the levator ani muscles will lengthen the urethra to 4.3 cm. Reflex contraction of the levator ani, as in changing from the supine to the erect position, will also increase urethral length to 4.3 cm. The urethral length of 35 normal women without urinary incontinence varied from 3.0–4.5 cm. with an average of 3.8 cm. both in the supine and standing positions.

Intravesical pressure in the normal individual varies also with type of activity. In the supine position the average intravesical pressure in the female is approximately 17 cm. water. On standing the pressure is increased to 32 cm. and on straining it is elevated to 60 cm. A portion of the intravesical pressure in the relaxed, supine position, and the increases beyond that pressure observed on standing, straining or coughing are due entirely to contraction of the striated muscle surrounding the body cavities.

When normal females cough or strain, a "beak" or "infundibulum" of bladder fluid contents enters the proximal third of the urethra and then returns to the bladder after cessation of exertion. Apparently the urinary sphincter cannot keep the urine confined entirely to the fundus of the bladder when intravesical pressure is increased abruptly; urine is pushed into the lumen of a portion of the urinary sphincter.

THE LESION

The basic abnormality common to female patients with stress incontinence was found to be an unusually short urethra when the patient assumed the standing position. The urethral length in the supine position in these patients was frequently within normal limits but on assuming the standing position, there was a shortening, collapse or telescoping of the urethra. It is evident that if the length of the urinary sphincter or urethra is decreased sufficiently, stress incontinence will result—particularly when it is known that stress forces urine part way down the urethra in the normal female. A 3 cm. urethral length in the standing position seems to be the critical length at which transition from continence to incontinence occurs.

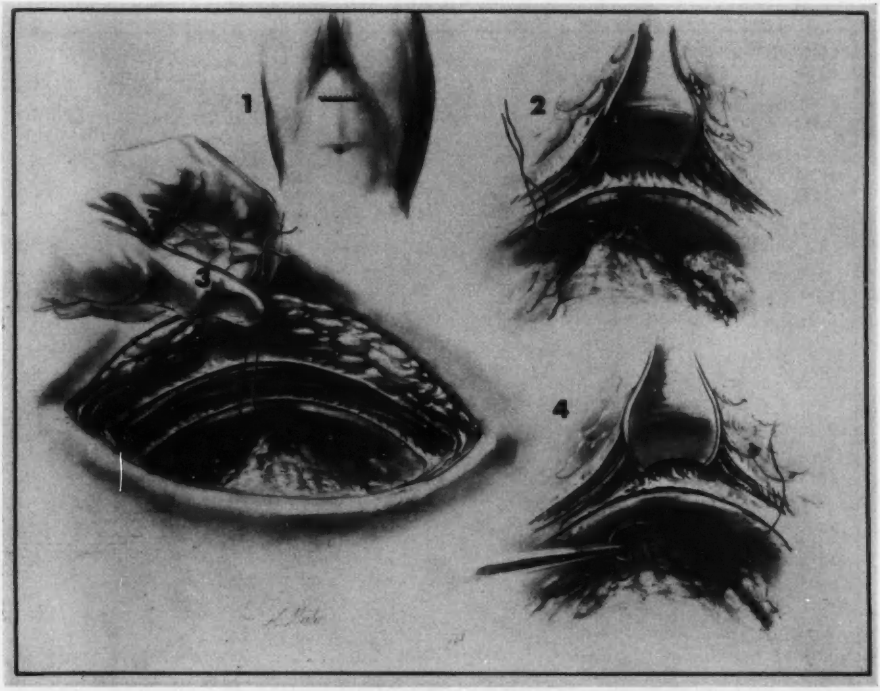
An abnormally short urethra is not invariably associated with stress incontinence and a normal length urethra in the standing position is not a guarantee against stress incontinence. Other fac-

tors such as intravesical pressure, status of the urethral epithelium and tonicity of the muscle and elastic tissues in the wall of the urethra play a part in determining the effectiveness of the urinary sphincter in maintaining urinary continence.

Intravesical pressure is an important factor in the apparently mysterious appearance and disappearance of stress incontinence under certain conditions. It has been shown that patients with large cystoceles and hernias do not develop high pressures on exertion. This is apparently due to the fact that a high pressure requires a compression of the body cavity by all of the striated muscles surrounding the cavity. If there is a weak spot in the muscular wall of the perineum or abdomen, the pressure will be dissipated by the bulging of the hernia or cystocele. Thus, a patient who is a potential candidate for stress incontinence because her urethra shortens abnormally in the erect position, may not show stress incontinence if she has a large cystocele. When the cystocele is repaired whith resultant increase in intravesical pressure on exertion, incontinence makes its appearance.

DIAGNOSIS

Since there are a number of types of urinary incontinence, one must perform a thorough examination in order to arrive at a correct diagnosis. The chief complaint of the patient with stress incontinence is involuntary loss of urine on exertion. After the physician performs the routine history, physical examination and urinalysis, he requests the patient to empty her bladder. The patient is placed in the lithotomy position and catheterized with a size 16 French calibrated retention catheter (5 ml. balloon). These catheters, now produced commercially by American Cystoscope Makers, Inc. and C. R. Bard, Inc., are graduated in centimeters for a distance of 5 cm. from the balloon. The catheter balloon is inflated and gently snugged against the vesical outlet; the urethral length is measured; the re-

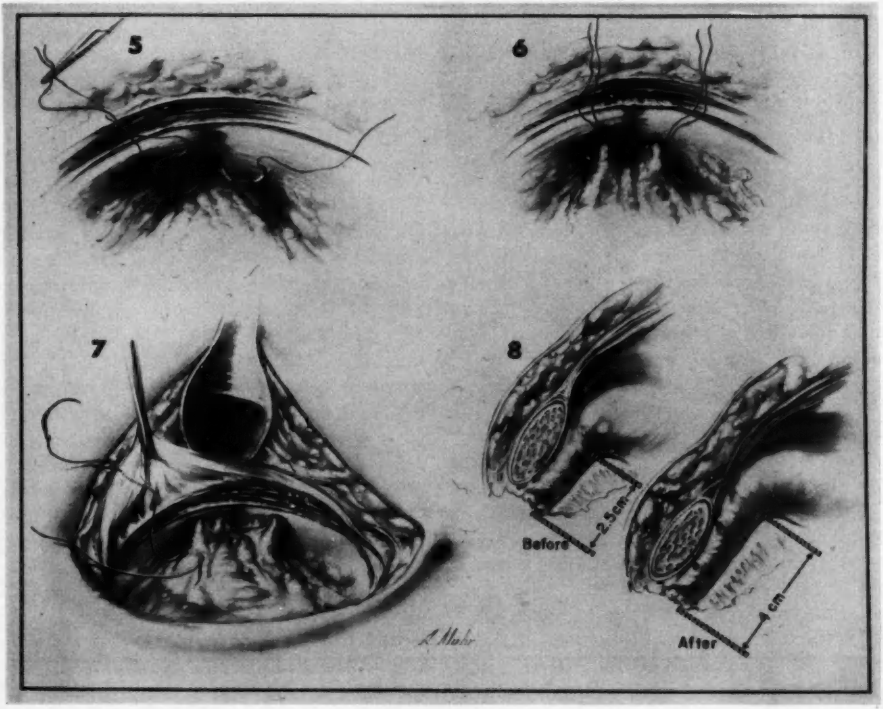


FIGS. 1, 2, 3, 4

sidual urine is checked and a cystometric examination performed. After distending the bladder to capacity the patient assumes the standing position with the catheter clamped and still in the bladder, and the urethral length is again measured. After the catheter is removed the patient is requested to cough or strain and urinary leakage observed. The patient is asked to empty her bladder and then reassume the lithotomy position for a second check of residual urine and endoscopic examination of the urethra and bladder. The urethra is carefully scrutinized for defects in the urethral wall and condition of the urethral epithelium. If the patient has no residual urine, a normal urethroscopic examination, a normal cystometric examination, loses urine on stress and exhibits a urethral length of 3.0 cm. or less in the erect position, she is a candidate for operation without undergoing any preliminary trial of perineal exercises or estrogen therapy. If the correct diagnosis is made and the appropriate operative procedure used, one can expect 100 per cent of operated cases to be cured of their stress incontinence. One must perform all of the examinations advised in order to arrive at the proper diagnosis and avoid pitfalls.

TREATMENT

Since the basic lesion in stress incontinence is shortening, telescoping or collapse of the urethra on standing, then its treatment is to lengthen the urethra and fasten it in the simplest and most certain fashion so that shortening of the urethra does not occur when the patient gets to her feet. This does not mean such unphysiological, indirect and uncertain procedures as colporrhaphy, fascial slings, uterine suspension, vesico-urethrolysis, etc. The concept that it is necessary to buttress the posterior aspect of the urethra is erroneous and should be discarded. Abundant evidence in the literature as well as our own data indicate that stress incontinence can occur without the presence of cystocele, urethrocele or uterovaginal decensus. When stress incontinence is associated with the presence of cystocele,



FIGS. 5, 6, 7, 8

simple fixation of the anterior surface of the urethra to overlying symphysis pubis and rectus fascia will cure the stress incontinence without obviously changing the status of the cystocele. *In essence, female stress incontinence is due to a lesion of the urinary tract and not the genital tract.* Operations for cystocele, urethrocele and uterovaginal decensus should not be used as primary therapy for stress incontinence.

A simple, effective operation designated as "Anterior Urethropexy" has been devised for the treatment of stress incontinence. After the patient has been given a spinal anesthetic, she is catheterized with a calibrated retention catheter, the bladder drained of urine and the catheter left inlying. The urethra is approached through a transverse incision made two fingerbreadths above the symphysis pubis (fig. 1). After incising the skin, subcutaneous tissue and rectus fascia, the recti muscles are retracted laterally to expose the bladder.

The patient is placed in moderate Trendelenburg position in order to move the contents of the peritoneal cavity cephalad and away from the operative field. The periurethral fat is gently wiped from the anterior surface of the urethra so that the urethral wall can be readily identified. Two parallel rows of interrupted chromic catgut sutures are taken through the anterior wall of the urethra and the overlying symphysis pubis and rectus fascia in order to stretch the urethra and fix it to immobile symphysis and rectus fascia.

The technique involves the use of zero chromic catgut suture material and a Mayo round point needle. The surgeon mentally divides the anterior urethral surface into two longitudinal halves. The first suture is placed through the most distal portion of the left half of the anterior urethral wall (fig. 2). The suture is taken in a transverse fashion through the entire urethral wall and incorporates about 1 cm. of tissue in the bite. Before continuing the suture through the periosteum of the symphysis, the suture is drawn taut and held close to the overlying symphysis in order to judge the place where the suture must be taken so that it will hold the urethra taut (fig. 3). The needle is then placed into the periosteum of the desired area and gently pushed and pulled *in the arc of the needle* through the periosteum (fig. 4). The ends of the suture are held while another suture is taken in a similar manner through the most distal portion of the right half of the anterior surface of the urethra (fig. 5). Each suture is then tied (fig. 6).

The next pair of sutures is placed about 1 cm. proximal and in a manner similar to the first pair. The third pair of sutures is placed 1 cm. proximal to the second pair; these sutures are usually taken in the region of the vesical outlet and fastened to overlying rectus fascia (fig. 7). Figure 8 illustrates a lateral view of the urethra before and after anterior urethropexy.

One can check the effect of anterior urethropexy immediately after the operation by noting the urethral length. The urethral length in the standing position can be obtained just prior to removal of the catheter on the fourth postoperative day. A urethral length varying from 4–5 cm. in standing position indicates that the operation has been performed properly.

SURGICAL CORRECTION OF MALE STERILITY

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This article pertains to a study of 157 patients who presented themselves with complete azoospermia in whom surgical exploration, or corrective surgery, was performed. Mechanical obstruction or lack of continuity of the vasoepididymal ductal system is the result of 1) complete or improper development of the ductal system, itself; 2) obstruction in the epididymis or in the vas due to postinflammatory constrictions or occlusion of the lumen or ejaculatory ducts; or 3) inadvertent or purposeful division of the vasa. Our records show that in these 157 patients the cause for the azoospermia, as nearly as we could describe it, was due to the following factors:

	Cases
1. Bilateral congenital absence of the epididymides	4
2. Bilateral failure of anatomic union between the vas and epididymis	6
3. Unilateral atrophy of testis caused by mumps orchitis with congenital absence of the epididymis and vas on the opposite side	5
4. Bilateral absence of both vasa with anomalies of the epididymides	5
5. Previous epididymectomy on one side with failure of union of the vas and epididymis on the other side	1
6. Inadvertent bilateral surgical ligation of the vasa deferentia during operations to repair inguinal hernia or correction of bilateral hydrocele or varicocele	7
7. Surgical division of the vasa deferentia for purposes of sterilization	55
8. Following bilateral vasostomy with injection of collargol, other organic silver solution, or dyes, after the method of Belfield	8
9. Patients in whom previous bilateral epididymitis had occurred, the inciting cause having been either the gonococcus or some so-called nonspecific pyogenic organism	66

Congenital maldevelopments of the vasoepididymal tract have received scant attention in both the anatomic and urologic literature. From our own fairly small experience, these anomalies are much more common than has previously been supposed or than any published statistics would indicate. Of 157 patients operated upon in our clinic, complete absence of the epididymides, proved at operation, was demonstrated in 4 patients. None of these patients had any idea of this condition. Both had normal testicles upon palpation. In one instance, a unilateral testicular biopsy showed what appeared to be perfectly normal testicular tissue. Six patients with bilateral failure of union between the vas and epididymis were operated upon in the hope of demonstrating the cause of azoospermia. In one instance, the vas and epididymis were present on the right side, but were not united. On the left side, the epididymis was completely absent and the vas was rudimentary. Two other patients gave a history of mumps orchitis on one side and subsequent atrophy of the testicle. There was continued azoospermia with a palpably normal testis on the opposite side. Scrotal exploration showed congenital absence of the epididymis and vas on the explored side in both patients. Congenital bilateral absence of the vasa was found in five other patients. In each of these, varying anomalies of epididymal development accompanied this deficiency.

A cross anastomosis of the vas has been done in some instances. This method has been used on 5 patients in this series. Two of these procedures were successful. One patient had had bilateral purposeful ligation of the vas to effect sterility; the other had suffered trauma which resulted in occlusion of the vas on one side to a hopeless extent, from the point of view of correction, but which allowed the vas, which was completely free and open from the globus major of the epididymis, to be brought across and anastomosed to the globus major of the epididymis on the opposite side. These procedures were all end-to-side anastomoses, and, in each instance, a splint was left in the lumen of the vas and brought out through the epididymis and the

scrotal skin and allowed to remain in place for seven to 10 days after the anastomosis had been effected. Of the 66 patients in whom sufficiently hopeful indications for success were present to warrant bilateral or unilateral epididymovas anastomosis, and upon whom subsequent followup examinations were possible for a period of at least six months, 19 were found to have evidence of spermatozoa in the ejaculate at some time or other during the first year. Unfortunately, the followup examinations on all of these patients are difficult, and in only 25 of the 61 patients was a satisfactory followup examination effected to determine end results. Of the 19, normal appearing spermatozoa were observed in the ejaculate, although often the number and motility were not accurately listed in the record. The record indicates that eight of these 19 apparently impregnated their wives and a successful pregnancy came to term with a living child after this procedure.

This fact would suggest that the re-establishment of exit of spermatozoa from a purely cytologic point of view, at least in somewhere around 40 per cent of the patients, but would also indicate that actual fertility was restored in not more than 10 to 16 per cent of the patients operated upon by this procedure. It is obvious that the followup on these patients, even though they are under fairly good control, lacks authenticity and accuracy because of the many-sided problems connected with conception and subsequent child-bearing.

It is evident that nothing can be done surgically to correct a bilateral congenital absence of the epididymis. In three of the 6 patients in whom bilateral failure of anatomic union between the vas and the epididymis was demonstrated, attempts were made to perform an end-to-side anastomosis of the vas to the epididymis. In all six of these patients, the lumen of the vas was proved to be open from the point of incision to the ejaculatory duct. In the fourth case, both vasa were composed of atrophic, sclerotic cords which were patent only above the external inguinal ring. Mechanically, this condition did not permit the attempt to anastomose the epididymis to the short end of the vas. In only 2 patients in whom end-to-side anastomosis was effected, spermatozoa were found in the ejaculate, and in 1 patient for only a very few months. They were few in number and a high percentage were morphologically atypical. Pregnancy did not result from any of these unions.

In considering the 7 patients in whom inadvertent bilateral surgical ligation of the vas deferens had been performed during operations to repair hydrocele or hernia, it was proved that three of the patients had a completely successful reanastomosis of the vasa with subsequent normal sperm count and normal-appearing motile sperm. Proved pregnancy with a full-term healthy child followed in 2 instances. Two of the patients with unsuccessful results were reoperated upon, but in neither instance was establishment of the lumen of the vas successfully effected.

Any patient who has undergone a bilateral inguinal or scrotal operation and later is proved to have azoospermia, should be accorded the advantage of a bilateral scrotal and inguinal exploration to determine whether or not the vasa have been ligated inadvertently during the procedure.

Prior to 1945, re-union of the vasa had been performed in 14 men who had previously been purposefully sterilized by bilateral vas resection. Nine of these patients had a successful outcome as evidenced by a careful series of followup examinations over a period of from two to 15 years. Since 1947, 44 additional patients have been seen who had undergone purposeful bilateral vas ligation or resection. All of these have been operated upon with the following results: In 10 patients, resection of the vasa had been performed so proximal to the globus minor of the epididymis that satisfactory re-union of actual vasal lumina was not possible. In each of these patients, an attempt was made to unite the proximal tortuous portion of the epididymis to the vas proper. In four of these patients, spermatozoa subsequently found in the ejaculate were unsatisfactory in number, shape and motility. One of these patients has subsequently become azoospermatic again. Pregnancy did not result in any instance. The remaining 34 patients were found to have a reasonably satisfactory anatomic condition to permit vasal reunion. This situation prevailed bilaterally in 26 and unilaterally in 8 patients. Of this group, 20 patients have had what appears to be a completely successful result, i.e. the sperm count has repeatedly been over 20 million per cubic centimeter with apparently normal

morphology and motility. In four of the remaining 14 of this group, spermatozoa were found for a period of 6 months, but subsequently disappeared completely from the ejaculate. Three of these patients were operated upon a second time, and none attained a successful result on the second attempt.

In the remaining 11 patients, no spermatozoa were ever demonstrated in the ejaculate after anastomosis, even though testicular biopsy and fresh material from the cut end of the vas had shown normal findings at the time of operation. None of these 11 patients has submitted to a second attempt at surgical correction.

SUMMARY

The mechanical causes of male sterility, as found in a series of 157 patients subjected to surgical exploration, are reviewed. The different procedures which have been used in an attempt to re-establish a satisfactory channel for the passage of spermatozoa have been thoroughly investigated and the results analyzed as carefully as possible. While the results obtained have produced both pessimistic and optimistic phases of opinion, continued and more widespread work along these lines seems warranted in the hope of restoring fertility to more of these patients.

251 E. Chicago Ave., Chicago 11, Ill.

DISCUSSION

DR. VINCENT J. O'CONOR (Chicago, Ill.): In order to save time I will be glad to answer any questions from the floor while we are showing the film.

VOICE: Have you had any fertility after the procedure you have done here?

DR. O'CONOR: Yes, about 22 per cent. Of that number there are persistent spermatozoa in the vas and epididymis. That is a pretty low average.

VOICE: It looks like you were using a lot of sutures in burying it.

DR. O'CONOR: Yes. First of all, you use two 00000 stainless steel sutures and mattress them down so as to pull the cut end of the vas well down into the head of the epididymis. Then you have to close the epididymis with 0000 chromic or some such fine material. That has to be closed quite tightly, water-tight, in order to keep leakage of sperm from resulting.

VOICE: Have you made any more pouches in the scrotal wall?

DR. O'CONOR: No, I haven't. Some years ago some of you may remember that I had some patients who had complete occlusion of the vas below the external inguinal ring, and they were anxious to have children. I created a dermal pouch in the center of the scrotum and put the cut ends of the vas into this pouch. One of these patients was a urologist from Louisiana, and he claimed to have impregnated his wife by artificial insemination from this pouch.

The other patient also used artificial insemination. He was from Little Rock, Arkansas. His wife was supposed to have aborted twice. After six, eight or ten months these vasa will close off and become solid cords and will cease to excrete sperm into the pouch. The question has arisen as to doing this in paraplegics. I have never done one in a paraplegic, but I have been told by three different people that they have had a successful result from artificial insemination using the pouch method. Just how accurate they are in their findings, I don't know.

VOICE: Do you have any pathological data to show how many of the little tubules in the epididymis seal off?

DR. O'CONOR: No, I haven't. Do you mean from a microscopic study point of view?

VOICE: Yes.

DR. O'CONOR: After the surgery?

VOICE: Yes.

DR. O'CONOR: No. These people, once they are operated on, either do or they don't. That is, you don't get a chance to see them again. Some of them will come back for more, but the ones who have re-anastomosis of the vasa and have an unsuccessful result—about 50 per cent of them want you to try it a second time, and then you naturally get all the tissue you want for microscopic study.

I think it would be rather difficult to persuade these other people to come back and have a portion of the epididymis removed for microscopic study. I have never done it. Actually, Lespinasse's theory was that if you could get one good tubule to unite to the lumen of the vas it might be all that might be necessary to restore fertility. In my mind, that is questionable. After all, we know that the number of sperm, and so on, have a lot to do with effecting pregnancy.

I talked to McLeod in New York, an anatomist, and he said he did not think anybody who had less than 10 million sperm could be a father. I told him I had a number of patients who had a sperm count of one million or less, and I was sure they had impregnated their wives. Five or six years later he wrote me and said he was convinced that a small sperm count was not necessarily a deterrent to pregnancy.

He further studied the situation. I think Dr. Hotchkiss and others who have perhaps given more attention to the medical treatment of male sterility could speak of that.

Fortunately, epididymitis is the thing that brings a lot of these people to the urologist—bilateral epididymitis.

Dr. Michaelson, of San Francisco, whom many of you know, became interested in male sterility. I think he is very much of an optimist in this work. One has to be an optimist to do any of this. Michaelson did a very useful thing in calling to our attention the fact that the anomalies of development of the epididymis and vas are a great deal more common than we previously believed.

I think this also shows that needle biopsy of the testicle is foolish and a wrong procedure. If you are going to find out whether or not a man has a testicular and a vasoepididymal system that is

competent, you should open the scrotum and look at it. If you are going to take a piece of testicular tissue, remove it as I showed you in the movie, in a surgical manner.

We have seen twelve or more individuals who have lost their testicles completely following needle biopsy. As you know, it is very easy if you puncture the tunica vaginalis or propria to get a pretty good size hole in it, and the testicular tissue will leak out into the scrotum. The patient will end up with complete atrophy of the testicle. I am against needle biopsy of the testicle.

There are very few patients who have had a careful followup on this subject. It is an extremely difficult thing to follow these patients and to get a satisfactory and authentic group of end result figures.

Dr. Reed M. Nesbit (Ann Arbor, Mich.): How many men in the room have seen sperm granuloma following vasoligation? Twelve. I have seen it twice.

It is a granuloma that develops as a result of the sperm which acts as a foreign body, as described by Mostofi.

Voice: Involving the whole testis?

Dr. Nesbit: Right. The Chair should not indulge in its prerogatives, but I would like to suggest that the elliptical method of anastomosis affords a greater size stoma than an end-to-end direct anastomosis.

VESICOURETHROGRAPHY

ROBERT LICH, JR., LONNIE W. HOWERTON AND LAWRENCE A. DAVIS

From the Department of Surgery, Section on Urology; and the Department of Radiology, University of Louisville School of Medicine, Louisville, Kentucky

The importance of vesical neck obstructive uropathies has long been recognized. However to our knowledge, a positive method for the critical diagnosis demonstrating both the existence and the degree of obstruction has not been described. It is our purpose to set forth such a technique and demonstrate the significant findings with x-ray reproductions. This presentation constitutes the first in a series of studies in which this technique has been extended to correlate vesical outlet obstruction with persistent or intermittent urosepsis in children and adults.

The structure and function of the bladder have been visualized by cinefluorography on many occasions, but this method has two inherent faults. The amount of radiation delivered to the patient is excessive and the film image size is such that resolution of structural detail is limited. We have used a technique using the image intensifier which eliminates both of these faults and provides film images that are readily available for study and comparison. In addition, during the procedure the upper and mid-urinary tract may be monitored and multiple films exposed to record even transitory though significant episodes of urinary tract disease.

In our opinion, to assure therapeutic success, bladder neck obstructions must be diagnosed and corrected before the ravages of this lesion are manifest by urinary tract decompensation as evidenced by ureteral reflux, bladder trabeculation, etc. When these phenomena are in evidence the process is relatively far advanced and requires correction beyond a simple revision of the initial causative lesion, i.e. bladder neck obstruction.

TECHNIQUE

The bladder is filled, by catheter, with 15 per cent hypaque* until the patient experiences a marked urge to void; or in the instance of infants, until there is an initiation of detrusor response. The filling of the bladder is monitored by the image intensifier and the mid- and upper urinary tract is repeatedly scanned for the possibility of ureteral reflux during this period of vesical filling.

After the catheter is removed the patient is instructed to void, or in infants, if micturition is not spontaneous, it is initiated by suprapubic pressure. At the momment that urethral filling begins several spot films are exposed to cover the period of voiding, the primary interest being to record the vesical neck and proximal urethra during the height of intraurethral pressure. This latter point is of extreme importance since it is only during this period that variations in the vesical neck and proximal urethra are positively indicative of vesical neck obstruction. During the act of voiding the upper urinary tract is scanned on several occasions to visualize the possibility of ureteral reflux. Ureteral reflux, like obstruction of the bladder neck, varies in degree and duration; i.e. it may occur during the mid-portion of voiding and completely disappear at the conclusion of micturition or it may be present after the completion of voiding and remain for a variable period of time.

At the conclusion of the voiding films the patient is instructed to empty the bladder completely in the privacy of a bathroom following which a final film is made to record residual contrast medium or persistent ureteral reflux. The amount of retained dye or urine is proportional to the degree of vesical neck obstruction and a significant amount may be retained which is not apparent to catheterization. The retention of infinitesimal amounts of urine in the bladder may occasion a persistent urinary tract infection of equal severity and tenacity as that occasioned by a considerable volume of residual. The existence of residual urine and not the amount is the factor of importance in recurrent or persistent urosepsis.

FINDINGS

The normal vesicourethrogram is characterized by a smooth, symmetrical, conical bladder outlet

* Supplied through the courtesy of Winthrop Laboratories.

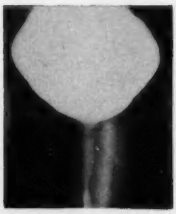

FIG. 1. Normal vesicourethrogram

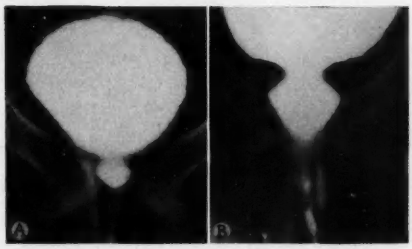

FIG. 2. *A*, moderately constricted vesical neck due to hyperplasia of bladder outlet shows secondary vesical trabeculation. *B*, more advanced vesical neck muscular hyperplasia as compared to *A*.

extending into a urethra of unvarying caliber suggesting a radidly continuous uninterrupted urinary flow (fig. 1). The normal bladder empties with great rapidity with virtually instantaneous completeness. On the other hand, obstructions of the vesical neck present an entirely different picture, at the height of intravesical and intraurethral pressure, which varies only with the degree of obstruction. Most often these obstructive lesions of the vesical neck are not distinctly visualized cystoscopically and in our hands even though the existence of the lesion was known a repeat cystoscopy was equally valueless in demonstrating the obstruction.

The urethrovesical pattern of vesical neck obstruction demonstrates a variable degree of bladder neck narrowing associated with proximal urethral dilatation. The characteristic urethral dilatation we have elected to term an "acorn deformity" of the proximal urethra. In our opinion this is occasioned by poststenotic pressure in the proximal urethra and cinefluorographic studies are in process to confirm this contention. The amount of "acorn deformity" in the proximal urethra varies proportionately with the degree of vesical neck obstruction. This observation has been confirmed repeatedly at the time of surgical revision of the vesical neck in these patients.

Figure 2 reveals the deformity of the proximal urethra which has been discussed. The degree of proximal urethral abnormality in figure 2, *B* is much more marked than in figure 2, *A* which was strikingly evident at the time of surgery in these two children. Again, let us emphasize that this lesion is visualized only at the height of intraurethral pressure during voiding and for this reason is it rarely visualized in the usual techniques employed in vesicourethrography.

CONCLUSION

A radiographic technique is described which accurately and consistently demonstrates vesical neck obstruction irrespective of degree since it records an image which represents a blend of both structure and function.

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PERIPELVIC EXTRAVASATION DURING INTRAVENOUS UROGRAPHY, EVIDENCE FOR AN ADDITIONAL ROUTE FOR BACKFLOW AFTER URETERAL OBSTRUCTION

FRANK HINMAN, JR.

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Extravasation of urine about the renal pelvis and upper ureter during intravenous urography, which we have studied in 5 patients during ureteral obstruction, does not indicate rupture of the pelvis but proves to be merely an extreme form of pyelosinous backflow. The present report describes our attempt to demonstrate the quasi-physiologic nature of this relatively infrequent phenomenon by means of observations on human beings and by injected preparations, correlated with descriptions of similar phenomena made by previous investigators. This study may contribute to the understanding of such related problems as periureteral fibrosis, periureteral "edema," the systemic and local effects of ureteral obstruction, and "physiologic" extravasation in contrast to actual pelvic rupture. It will be shown that under conditions of complete ureteral obstruction, pelvic backflow may start by way of the fornices, pass along the calyceal wall, and subsequently will reach the peripelvic tissues (fig. 1).

CLINICAL OBSERVATIONS ON PERIPELVIC EXTRAVASATION

Recent experience with 5 patients led to the following observations.

A. The *"edema" fluid* commonly found perireterally at operation for ureteral obstruction is not necessarily lymphatic in origin. An azo dye (pyridium), administered orally before exploration of the flank in a woman with an accidentally ligated ureter, was seen in high concentration in the fluid about the pelvis and ureter at operation. This was not true lymphatic fluid, since the concentration of the dye showed that it arose rather directly from the renal pelvis. Its diffuse distribution (in contrast to its being confined to the channels seen in lymphatic backflow at urography) and its association with "extravasated" contrast medium which was seen on urography in this patient (see later) leads us to conclude that it originated from the renal pelvis, passing by way of the fornices out through the hilus.

B. The *contrast medium* distributed about the renal pelvis on intravenous urography during ureteral obstruction, which gives the appearance of peripelvic extravasation, provides more direct clinical evidence of communication between the fornices and the peripelvic space.

Five cases of peripelvic extravasation have been seen and are described (table 1).

Case 1. N. T., a 42-year-old woman, suffered left flank pain on May 4, 1959, five days after total hysterectomy. Intravenous urograms taken on the eighth day showed extravasation about the left renal pelvis (fig. 2, *A* and *B*). Retrograde pyelograms, taken after a spiral-tipped catheter had been manipulated through a deviated stenotic segment of the ureter 2.5 cm. above the bladder, showed no pelvic leakage (fig. 2, *C*).

At nephrostomy (elected because of the extravasation and the inability to relieve the lower ureteral obstruction completely) the tissue within Gerota's fascia was very wet and was deeply stained with the pyridium that the patient had taken orally prior to operation. The pelvis itself showed no abnormalities.

After 2 months, nephrostograms revealed adequate flow past the stricture and the tube was removed. The urine is now sterile.

Comment: Peripelvic extravasation was seen on roentgenologic studies and was confirmed by the finding of azo dye inside Gerota's fascia. Had we realized the semiphysiologic nature of the roentgenologic changes from the absence of leakage on the retrograde pyelograms, we would have avoided nephrostomy drainage.

Case 2. J. I., a 48-year-old dentist, who had a history of colicky right flank pain for 20 years, was admitted on May 13, 1959, after 24 hours of sharp right lower quadrant pain associated with vomiting.

Intravenous urograms showed extravasation of dye about the right renal pelvis (fig. 3, *A*). The column of dye was obstructed about 12 cm. below the ureteropelvic junction. Little calyceal dilatation was present.

A stone manipulation was done, during which a 3.9 mg. calcium oxalate calculus was extracted. An immediate bulb ureterogram failed to produce extravasation (fig. 3, *B*). The patient was discharged 2 days later.

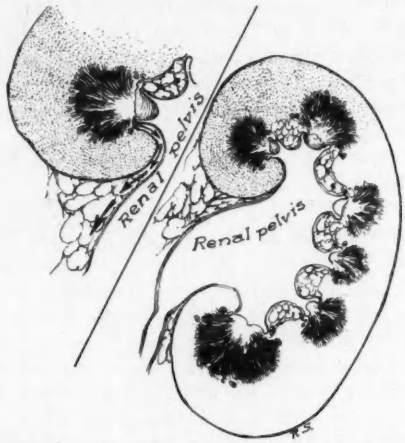

FIG. 1. Route of backflow in peripelvic extravasation.

Comment: Since we saw this patient with extravasation soon after the patient in case 1, we merely extracted the stone and provided no perirenal drainage.

Case 3. N. D., a 48-year-old man, was awakened by pain in the left lower quadrant which radiated into the left flank. He had no urinary symptoms. He was admitted to the hospital on May 2, 1955. An intravenous urogram taken at this time showed that function on the left was delayed and there appeared to be extravasation of medium around the renal pelvis and upper third of the left ureter (fig. 4, *A*).

The following day, the patient's temperature had risen to 38.4°C. Cystoscopy showed some delay in the appearance of indigo carmine on the left. Fifteen cubic centimeters of clear urine were aspirated from the left renal pelvis. Films made after the pelvis was filled showed no extravasation (fig. 4, *B*). The catheter remained in place overnight. Intravenous urograms taken after 8 days, and taken again 2 years later, were normal. No stone was recovered.

Comment: Although the extravasation was not interpreted as physiologic at the time, no operative procedure was done since the retrograde pyelogram showed no leakage from the renal pelvis. The patient's subsequent course demonstrated this to be the correct approach.

Case 4. L. L., a 64-year-old man, had an attack of severe, steady, right flank pain with

TABLE 1. *Five cases of peripelvic extravasation during intravenous urography*

Case Number	Pt.	Cause	Intravenous Pyelogram	Retrograde Pyelogram	Operation	Result
1	HT	Partial ureteral ligation	Peripelvic extravasation	? Normal	Drainage; nephrostomy	Ureter patent in 2 months; patient well
2	JI	Ureteral calculus	Peripelvic extravasation	Normal	Stone manipulation	Discharged in 2 days
3	ND	? Ureteral calculus	Peripelvic extravasation	Normal	Indwelling ureteral catheter	Immediate recovery
4	LL	? Ureteral calculus	Peripelvic extravasation	Not done	Drainage of flank, pyelotomy	Drainage 3 weeks; recovered
5	JR	Ureteral calculus	Peripelvic extravasation	Not done	Ureterolithotomy	Discharged in 6 days

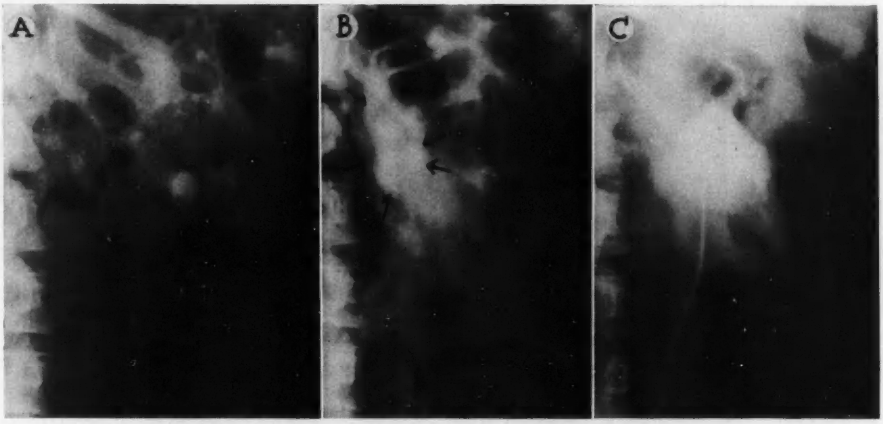

FIG. 2. Case 1. Partial ligation, lower ureter. *A*, 5 minute intravenous urogram shows absent psoas shadow and beginning peripelvic accumulation of contrast medium. *B*, 20 minute urogram. Contrast medium now fills entire peripelvic space. *C*, retrograde pyelogram later same day shows no direct pelvic leakage.

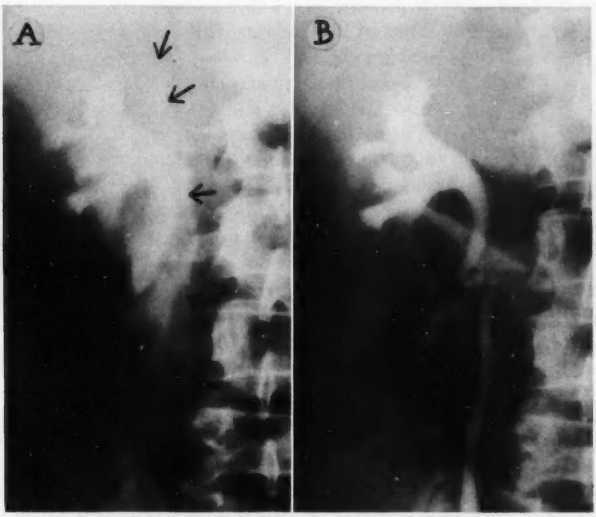

FIG. 3. Case 2. *A*, ureteral calculus. A 20 minute intravenous urogram shows diffuse peripelvic distribution of contrast medium. *B*, bulb pyelogram which shows that no direct pelvic leakage has occurred.

radiation into the groin on March 5, 1955, which was associated with tenderness at the right costovertebral angle. Intravenous urograms, which were taken immediately, showed no calculi, but demonstrated extravasation of dye about the right renal pelvis and along the course of the ureter (fig. 5). Immediate exploration revealed wet retroperitoneal tissue, the fluid spreading all the way to the pelvic brim. No perforation was found in the pelvis, nor was a stone located in the ureter. The pyelotomy was left open and the retroperitoneum drained. His postoperative course was marked by prolonged urinary drainage but he subsequently completely recovered.

Comment: Operation was done on the assumption that pelvic rupture had occurred, but none was found. In retrospect, nonoperative treatment would have been adequate, especially if a retro-

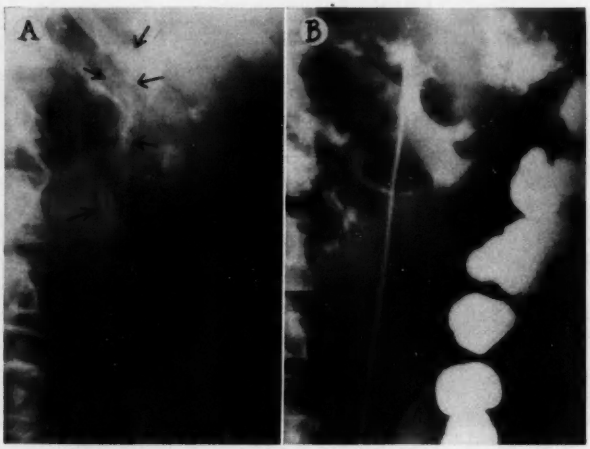

FIG. 4. Case 3. *A*, probable ureteral calculus. A 15 minute intravenous urogram shows peripelvic extravasation. *B*, retrograde pyelogram. No pelvic defect seen.

FIG. 5. Case 4. Probable ureteral calculus. A 20 minute intravenous urogram shows marked peripelvic and periureteral spread of contrast medium.

FIG. 6. Case 5. Ureteral calculus. A 1 hour intravenous urogram shows obstructing stone and distribution of contrast medium about upper margin of pelvis.

grade pyelogram had been done, which would have shown that pelvic rupture did not exist.

Case 5. J. R., a 44-year-old psychiatrist, had an attack of acute left renal colic with radiation of pain to the testis on April 26, 1960. A plain film showed a 8 mm. stone in the region of the left renal pelvis, but intravenous urograms the following day showed that the stone had moved 8 cm. down the ureter. Extravasated contrast medium could be seen about the superior border of the pelvis (fig. 6). Because the stone had not moved by the following day, it was removed operatively. Considerable "edema" was encountered inside Gerota's fascia at operation.

Comment: Ureteral obstruction resulted in a localized extravasation of contrast medium, the extent of which was demonstrated at operation by the distribution of fluid (urine) in the periureteral spaces.

C. *Abnormal fibrosis* about the upper ureter and renal pelvis may be explained by peripelvic extravasation. An illustrative case follows:

J. S., a 31-year-old man, had had previous attacks of right renal colic with hematuria, but no stones were recovered. Ten days before admission he noted hematuria and dysuria. On December 13, 1959, eight hours before admission, he had an attack of right flank pain with radiation into the testis, and he vomited.

An intravenous urogram made on entry showed

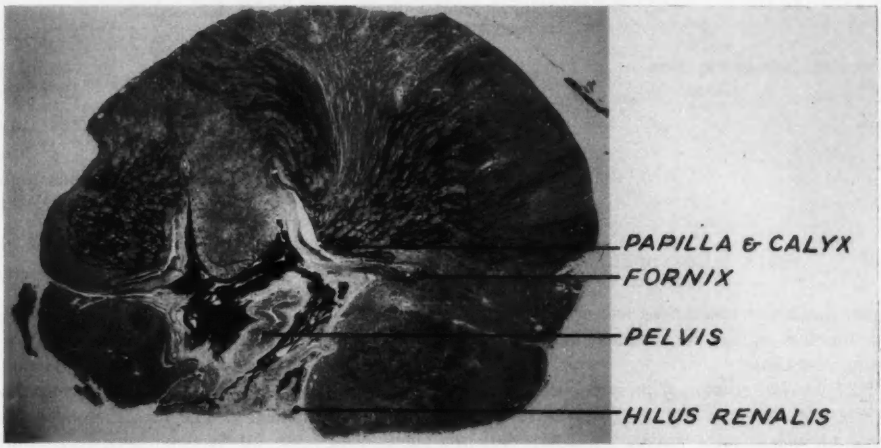

FIG. 7. Cross-section of calyx and margin of pelvis showing spread of India ink to perifornical region (2-week-old infant).

a stone at the right ureteropelvic junction of the lower segment of a double kidney. No extravasation was seen.

On the third day, since the stone had not moved, a ureterolithotomy was done through a Foley muscle-splitting incision. Minimal retroperitoneal "edema" was found, but the ureter was involved in a dense fibrous reaction which bound it firmly to the psoas muscle, as if a previous operation had been performed on the ureter. The stone was extracted through a short incision in the ureter. Urine drained for 7 days, and recovery was complete.

Comment: It seems reasonable to explain these findings on the basis of the effects of the peripelvic urinary extravasation that had occurred with the patient's previous attacks of ureteral obstruction.

An instance of extensive periureteral fibrosis obstructing the upper ureter in association with a pelvic stone has come to the author's attention. It will be reported separately by Dr. T. L. Griffith. It is possible that this case represents a more extreme late result of peripelvic extravasation, perhaps associated with infected urine.

EXPERIMENTAL OBSERVATIONS ON PERIPELVIC EXTRAVASATION

Fresh kidneys from adult and infant patients were obtained at autopsy, and were cleared of perirenal fat. A blunt adapter mounted on a 5 cc syringe was applied to the juncture of the renal pelvis with the hilar connective tissue and 2 to 4 cc of India ink was injected under pressure.

Microscopic sections showed that the ink spread along the wall of the pelvis, permeated the connective tissue separating the calyx from the renal parenchyma, and finally distributed itself around the papilla in the fornical tissue (fig. 7). This distribution of dye is interpreted as evidence that a potential route exists for the spread of substances between the fornix and the peripelvic region.

DISCUSSION

The relative importance of the venous and lymphatic drainage of the kidney in carrying off the urine which escapes by backflow after obstruction to the ureter is being re-examined.[1, 2] How the urine reaches these vascular structures had been determined previously.[3, 4] Our observations that pyridium-stained urine will infiltrate the perirenal connective tissue after lower ureteral obstruction, and that frank peripelvic and periureteral extravasation of opaque urine can be seen during intravenous urography

[1] Goodwin, W. E. and Kaufman, J. J.: Renal lymphatics. II. Preliminary experiments. J. Urol., **76**: 702, 1956.

[2] Murphy, J. J., Myint, M. K., Rattner, W. H., Klaus, R. and Shallow, J.: The lymphatic system of the kidney. J. Urol., **80**: 1, 1958.

[3] Fuchs, F.: The Flow of Water Through the Kidney. New York: Manhattan Printing Co., 1944.

[4] Narath, P. A.: Renal Pelvis and Ureter. New York: Grune and Stratton, 1951.

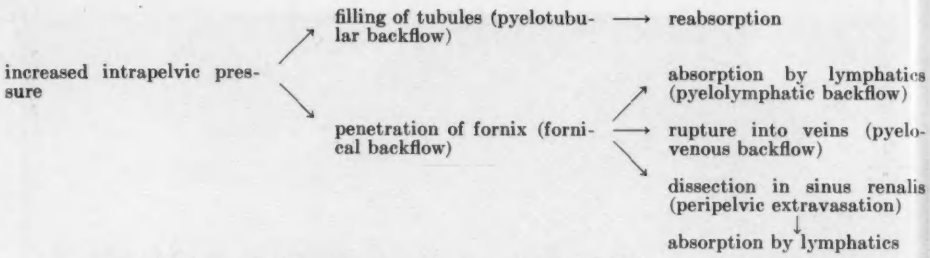
filling of tubules (pyelotubular backflow)
reabsorption
increased intrapelvic pressure
absorption by lymphatics (pyelolymphatic backflow)
penetration of fornix (fornical backflow)
rupture into veins (pyelovenous backflow)
dissection in sinus renalis (peripelvic extravasation)
absorption by lymphatics

FIG. 8. Schema of ultimate routes of urinary backflow after ureteral obstruction

under similar circumstances, led us to re-examine the function of the renal sinus during "pyelovenus" backflow.

Backflow (the relation of peripelvic extravasation to routes of backflow) (fig. 8). In order to understand peripelvic extravasation, it is necessary to relate it to other forms of backflow. Three major types of backflow can be described, which are actually different phases of the same process, since all are dependent on penetration of the fornix of a calyx by urine (fig. 1).

Fornical backflow (pyelosinous transflow):

a. "Pyelolymphatic" backflow (sinolymphatic absorption).

b. Pyelovenous backflow (sinovenous ingression), to which we would add the form described in the present series:

c. Peripelvic extravasation. Notice that "pyelovenous backflow," a term used by Hinman, Sr. in 1924[5] and used generally for all types of backflow, forms just one type in the classification, since it actually is part of the fornical backflow in which the urine escapes by way of the lymphatics, the veins, or, as we shall see, by way of the pericalyceal and perirenal tissues.

(We will not discuss a separate type of backflow, pyelotubular backflow, which has a characteristic roentgenographic appearance in retrograde pyelography (tufts are seen as a result of filling of the collecting tubules by way of their openings on the papilla). Besides, its appearance on intravenous urograms cannot be distinguished from the more common occurrence of concentration of the dye in the collecting tubules during excretion).

Fornical backflow, a necessary precursor to pyelolymphatic and pyelotubular backflow is, as would be expected, a more common finding on urograms (including those made not only by retrograde injection but also by the intravenous method) than other forms of backflow. The horn-shaped outflow (Narath) is readily recognized roentgenographically. The fact that such backflow occurs on intravenous urography during abdominal compression or with some other obstruction to the ureter is less well appreciated. Fuchs in 1931[6] first described the phenomenon which occurred during an attack of renal colic, the cause of which was not determined. Since then, well over one hundred cases have been described. The over-all incidence of backflow with compression in intravenous urography is about 2.2 per cent (table 2). Olsson[12] described and illustrated the sequential changes of fornical backflow in detail.

a. Pyelolymphatic backflow may occur with either retrograde or intravenous pyelography. The wavy outlines of the lymphatic channels coursing toward the midline are not uncommonly seen after forceful retrograde injection of opaque solutions, arising from an irregular break which may be seen in one or more fornices. Reabsorption by this route may be complete in a few minutes.

b. Pyelovenous backflow: The urine which contains opaque medium may tear the veins away from the renal parenchyma by distending the tissues just outside the fornix, and cause the dye to spread into a venous plexus. This is a common occurrence in experiments on excised kidneys. It is much less often observed under clinical conditions, probably because the dye is carried away too rapidly to register on the film or because the insult is less traumatic.

c. Peripelvic extravasation: We can now ask

[5] Hinman, F. and Lee-Brown, R. K.: Pyelovenous back flow. J.A.M.A., **82:** 607, 1924.

[6] Fuchs, F.: Die Hydromechanik der Niere. Anatomische und experimentelle Grundlagen, biologische und klinische Bedeutung. Ztschr. urol. Chir., **33:** 1, 1933.

TABLE 2. *Intravenous urograms showing only fornical rupture*

Author	Year	Number of Cases	Cause		
			Ureteral stone	Abdominal compression	Other
Fuchs[6]	1931	1			×
Hendriock[7]	1934	1	? (colic)		
Fuchs[8]	1936	1	?		
Wulff[9]	1936	1 (1.2%)	×		
Lindbom[10]	1943	1	×		
Lindbom[10]	1943	15 (1.6%)		×	
Coliez[11]	1947	1	×		
Olsson[12]	1948	86 (2.5%)		×	
Boyarsky and associates[13]	1955	17 (2.9%)		×	
Total reported cases		124 (2.2%)			

the question: How is peripelvic extravasation related to other forms of backflow?

Our study of cross-sections of normal human kidneys which we injected with India ink from the rim of the hilus renalis suggests the probable route for escape of pelvic contents after they traverse the fornical barrier, that is, by way of the sinus and hilus.* However, earlier workers believed that this route was closed to urine for structural reasons. Henle,[16] in the original description, concluded that the connective tissue within the sinus renalis obliterated any potential space, and other investigators have pictured an actual diaphragm closing the hilus (fig. 9). Narath[17] describes these relationships:

"Close to the hilum the adherence of the capsule becomes more and more evident, and here it is impossible to strip the capsule off without tearing into the parenchyma. The fibers of the capsule spread in brushlike manner into the cortex and over to the extrarenal part of the pelvis or the ureter and onto the blood vessels, joining with their adventitia. In this way the hilum is sealed off, the capsule forms a diaphragm around the pedicle. So the capsule represents a closed bag in which the whole complicated structure of the renal pelvis, the sinus renalis with its vessels and the parenchyma is embedded."

"How firmly the fibrous capsule is adherent to the extrarenal part of the pelvis is well known to every surgeon who seeks to expose a greater area of the true pelvis for reasons of pyelotomy—lifting the parenchyma away from the pelvis. In

[7] Hendriock, A.: Intravenöse Urographie und pelvirenaler Übertritt. Zentralbl. Chir., **61:** 1822, 1934.

[8] Fuchs, F.: Nierenbeckenextravasate. Ztschr. Urol., **30:** 423, 1936.

[9] Wulff, H. B.: Die Zuverlässigkeit der Röntgendiagnostik—besonders hinsichtlich des Wertes der Urographie—und die Prognose bei Nieren-und Harnleitersteinen. Acta radiol., suppl. 32, 1936.

[10] Lindbom, A.: Fornix backflow in excretion urography; its significance in the differential diagnosis of tuberculosis of the kidney. Acta radiol., **24:** 411, 1943.

[11] Coliez, R.: Les signes radiologiques de stase et de surpression urétéro-rénale au cours de l'urographie intra-veineuse. J. de radiol. et d'électrol., **28:** 311, 1947.

[12] Olsson, O.: Studies on back-flow in excretion urography. Acta radiol., suppl. 70, 1948.

[13] Boyarsky, S., Taylor, A. and Baylin, G. J.: Extravasation in excretory urography. Urol. internat., **1:** 191, 1955.

[14] Dorland's Illustrated Medical Dictionary, 23rd ed. Philadelphia: W. B. Saunders Co., 1957.

[15] Harper's Latin Dictionary. New York: American Book Co., 1907.

* The renal *hilus* (pl. hili, pron. hī-lī (hilus renalis) is the "opening in the concave edge of the kidney through which the vessels and nerves enter," (Dorland)[14], and was called the porta renis by the earlier anatomists. *Hilum* (pl. hila) (a primitive of the Latin nihilum, "a little thing, a trifle") (Harper's Latin Dictionary[15]), is an older form which is insisted upon by some authors, notably Narath, but is placed as an alternative by the standard medical dictionaries. The ending in *us* was used by Henle[16] in 1872 when he first distinguished the hilus renalis (the rim) from the sinus renalis (the hole or space), and was adopted by the Basle Nomina Anatomica (BNA). Hilus would seem, therefore, to be the preferrable form.

[16] Henle, J.: Handbuch der systematischen Anatomie des Menschen. Braunschweig, F. Vieweg und Sohn, 1866–72.

[17] Narath, P. A.: Renal Pelvis and Ureter. New York: Grune and Stratton, 1951, p. 156.

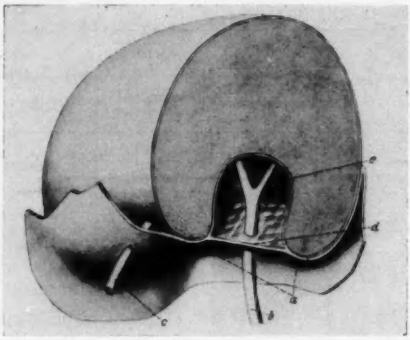

FIG. 9. Relation of capsule to pelvis, according to Fuchs,[6] p. 7.

order to accomplish this, the dense connective tissue between capsule and pelvis must be dissected with the scalpel. It is impossible to do it in a blunt manner."

"The hilum, though often large in itself, is considerably narrowed by the pelvis and the blood vessels so that the distances which must be bridged by the capsulae are not too great. The various structures that enter the hilum prevent an even and flat formation of a capsular diaphragm. On anatomic section, the formation is rather irregular, but still represents a membrane that seals off the sinus renalis and separates the sinus fat from the fatty tissue of the adipose capsule at the hilum."

In summary Narath[18] states, "Leakage of absorbed material from the sinus renalis into the retroperitoneal connective tissue is not easily possible. The capsule with its firm adherence to the parenchyma and the structures of the hilum prevents such an escape." Despite this conclusion, Narath shows films (his figures numbered 210 and 220) which we would interpret as showing peripelvic and periureteral distribution of dye, although he labelled them "sinolymphatic absorption." From our injection studies in excised kidneys we determined that once a particulate injected substance reached a point in the intrarenal peripelvic space, it spread widely in that space rather than entering the veins or lymphatic vessels. It would seem reasonable to assume that under some circumstances urine could utilize the same route, in reverse.

[18] Ibid, p. 306.

Indeed, Fuchs[19] has stated "that if extravasate does not come in contact with a vein, there is propagation towards the hilus and in such cases there are no preformed channels available." The peripelvic connective tissue is relatively loose and infiltrated with fat, so that an anatomic route exists between the rim of the calyx and the renal hilus (fig. 1). The existence of such a route might reasonably be assumed on embryologic grounds since the bud of the wolffian duct pushes its way into the mesonephric blastema, and in effect, invaginates it around its divisions. In fact, Windholz[20] made use of the pericalyceal fat to visualize the internal structure of the kidney.

The observation that a peripelvic route may be taken by urine during retrograde pyelography was first made in 1935 (table 3), when Heckmann[21] obtained peripelvic extravasation on a retrograde pyelogram even though he had not passed the catheter into the renal pelvis, and so could not have perforated the collecting structures. Intravenous urograms taken 2 weeks later were normal and no defect was found at autopsy, which was further evidence that actual perforation of the pelvis had not occurred (although the author believed that it had). Others[4, 19, 22] have made similar observations.

Peripelvic extravasation was first described on an intravenous urogram, made during abdominal compression, by Narath[23] in 1938. His illustration clearly shows extravasation about the pelvis and ureter inside Gerota's fascia. However, a retrograde pyelogram had been made previously (with the catheter only in the lower ureter) and the kidney was involved in tuberculosis. After removal of the kidney, Narath filled the pelvis with indigo carmine and could detect no leakage. These findings suggest that the extravasation arose from backflow at the fornix rather than from rupture of the pelvis.

[19] Köhler, R.: Investigations in retrograde pyelography; a roentgenological and clinical study. Acta radiol., suppl. 99, 1953, p. 46.

[20] Windholz, F.: The roentgen appearance of the central fat tissue of the kidney: Its significance in urography. Radiology, **56:** 202, 1951.

[21] Heckmann, K.: Ausfliessen des Kontrastmittels in das retroperitoneale Bindgewebe bei der retrograden Pyelographie. Fortschr. geb. Röntgenstrahlen, **52:** 601, 1935.

[22] Puigvert-Gorro, A.: Tratado de Urografía Clínica. Barcelona: Editorial Labor, 1944.

[23] Narath, P. A.: Extrarenal extravasation observed in the course of intravenous urography. J. Urol., **39:** 65, 1938.

TABLE 3. *Retrograde pyelograms showing peripelvic extravasation*

Author	Year	Number of Cases	Cause	Subsequent IV Pyelogram	Author's Figure Number
Heckmann[21]	1935	1	"Bulb" pyelogram	Normal	3
Puigvert[22]	1944	1	Retrograde pyelogram		64
Narath[4]	1951	1	Retrograde pyelogram	Extravasation	219, 220
Köhler[19]	1953	5	Retrograde pyelogram		166, 17b, 18a

TABLE 4. *Intravenous urograms showing peripelvic extravasation*

Author	Year	Number of Cases	Ureteral Stone	Abdominal Compression, Duration	Other	Author's Figure Number	Treatment
Narath[23]	1938	1		×		2	Nephrectomy
Renander[24]	1941	1	?			1	Nephrectomy
Olsson[12]	1948	6	× (all lower ureter)			17b, 18c	None
Olsson[12]	1948	3		55, 33, 13 minutes		9a, 10a, 10b	None
Olsson[25]	1953	2	×			166, 167	None
Persky and Joelson[26]	1954	1	×			1b	None
Weiner and associates[27]	1957	1		×		3	None
Fajers and Idbohrn[28]	1957	1	?			1	Nephrectomy
Forsythe and associates[29]	1958	3	×			1, 3	Various
Forsythe and associates[29]	1958	4			×	2, 4, 5, 6	Various
Hinman	1960	1			Ureteral ligation	2	Nephrostomy and drainage
Hinman	1960	1	×			3	Manipulation
Hinman (MacDonald)	1960	1	?		Ureteral obstruction	4	Indwelling catheter
Hinman (Schulte)	1960	1	?			5	Pyelostomy and drainage
Hinman	1960	1	×			6	Ureterolithotomy

Since 1938, four more cases of peripelvic extravasation after abdominal compression have been described (table 4). Compression lasted for as long as 55 minutes in one instance.[12] It is probable that Kitamura's[30] cases are examples of lymphatic backflow.

Pathologic obstruction of the ureter, usually by an impacted stone, accounted for 17 more

[24] Renander, A.: Another case of spontaneous rupture of the renal pelvis. Acta radiol., **22:** 422, 1941.

[25] Olsson, O.: Backflow in excretion urography during renal colic. In: Modern Trends in Diagnostic Radiology. J. W. McLaren, ed. New York: P. B. Hoeber, 1953, 2d series, pp. 214–217.

[26] Persky, L. and Joelson, J. J.: Spontaneous rupture of renal pelvis secondary to a small ureteral calculus. J. Urol., **72:** 141, 1954.

[27] Weiner, M. E., Alcorn, F. S. and Jenkinson, E. L.: Subcapsular rupture of the kidney during intravenous urography. Radiology, **69:** 853, 1957.

[28] Fajers, C. M. and Idbohrn, H.: Peripelvic reflux simulating a tumor of the renal pelvis. Urol. internat., **5:** 187, 1957.

[29] Forsythe, W. E., Huffman, W. L., Schildt, P. J. and Persky, L.: Spontaneous extravasation during urography. J. Urol., **80:** 393, 1958.

[30] Kitamura, K. and Honda, T.: Statistische Boebachtungen über Refluxschatten. Japan. J. Derm. Urol., **36:** 537, 1934.

cases of peripelvic extravasation after intravenous urography (table 4).

FACTORS IMPORTANT IN INITIATING AND PERPETUATING BACKFLOW

Köhler[19] found the pressure needed to initiate backflow to be between 80 and 100 mm. Hg, but Ross[31] obtained backflow with pressures as low as 15 mm. Hg. Moreover, pressures as high as 100 mm. Hg did not necessarily bring about backflow. In fact, the average pressure during Ross' retrograde studies with backflow was slightly less than in those without backflow. Kiil[32] found that the rate of increase in pressure was a more important factor than the absolute rise.

That intrapelvic pressure is reduced during backflow is illustrated clearly by Olsson[12] in his figures 5, *A* and *B*. Here reduction in the degree of ureteral and pelvic dilatation occurs even though compression of the ureters is maintained. This agrees with experimental observations that once backflow is established, less pressure is required to maintain it. The tone of the renal pelvis probably plays a role, since in all such cases pelvic dilatation is minimal. Observations on the present cases illustrate this point. In each case, although some calyceal overfilling can be seen on the urograms, there is minimal hydrocalicosis. Moreover, some filling of the collecting structures is seen in contrast to the nephrogram without pyelogram usually seen with this degree of obstruction.

We can assume that in those patients who show only a nephrogram an adequate route of backflow has not been established and the contrast medium must remain within the renal tubules. Passage of an ureteral catheter immediately produces a pyelogram because it releases the intrapelvic pressure and allows the tubular dye to pass into the renal pelvis.

In other cases, in which fairly clear pyelograms are seen but no backflow can be detected, urine probably passes into the lymphatic or venous circulation and proceeds undetected by present radiographic techniques. This "circulation"

[31] Ross, J. A.: One thousand retrograde pyelograms with manometric pressure records. Brit. J. Urol., **31:** 133, 1959.

[32] Kiil, F.: The Function of the Ureter and Renal Pelvis; Pressure Recordings and Radiographic Studies of the Normal and Diseased Urinary Tract of Man. Philadelphia: W. B. Saunders Co., 1957.

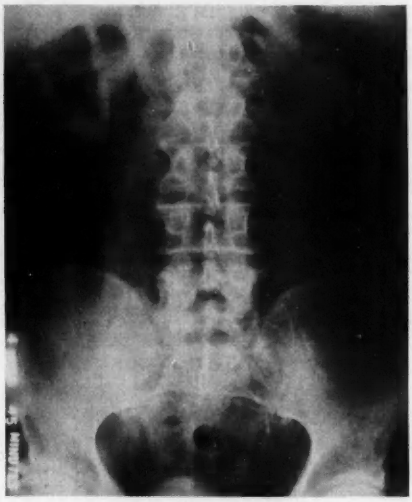

FIG. 10. Intravenous urogram (4¾ hours) with right ureteral obstruction shows persistent pyelogram on opposite side due to continued backflow of dye from obstructed side.

permits the calyces and renal pelvis to fill on the obstructed side, and moreover allows recirculation of the dye so that a pyelogram can still be found on the nonobstructed side hours after the injection (fig. 10).

The appearance of extravasated dye during urography performed during ureteral obstruction from calculi occurs rapidly (within 10 minutes) while that induced by concomitant abdominal compression is delayed (13 to 55 minutes). From this it may be concluded that pathways for backflow become established during the longer periods associated with calculous ureteral obstruction so that they appear immediately after injection of the opaque medium. On the other hand, if the obstruction and injection are simultaneous as with abdominal compression, more time is required for the routes to be established and opacified.

That the route is not maintained during long-standing obstruction is shown in an oblique way by recent experiments of Guze and Beeson.[33] If cortisone is given during the period of ureteral ligation, the resulting hydronephrosis is much less marked than if no anti-inflammatory agent is used. Our interpretation of these results is that

[33] Guze, L. B. and Beeson, P. B.: The effect of cortisone on experimental hydronephrosis following ureteral ligation. J. Urol., **78:** 337, 1957.

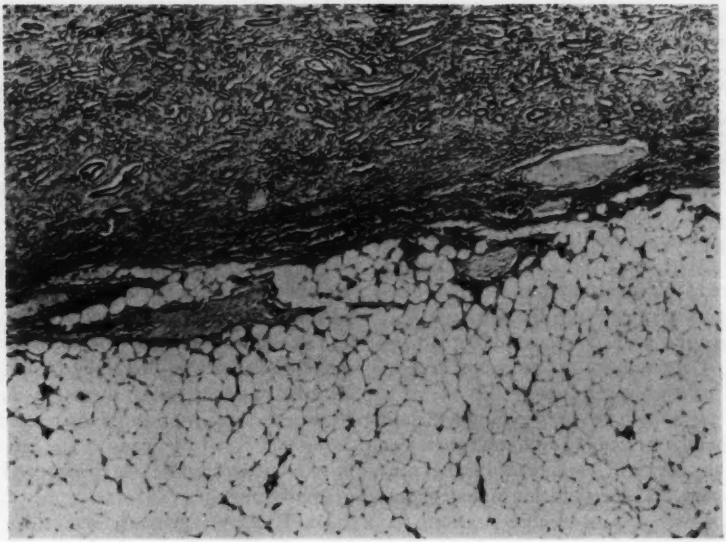

FIG. 11. Blocking of perirenal lymphatics in chronic urinary obstruction, from Helmke[35]

one effect of cortisone is to delay the perifornical inflammatory reaction and so allow the backflow to continue. This reduces intrapelvic pressure and decreases the damage to the kidney by hydronephrosis.

PERIPELVIC FIBROSIS

That fibrosis in the peripelvic and periureteral tissue could result from "physiologic" urinary extravasation is supported by several observations other than those, described in the clinical section, in which periureteral fibrosis was found during operations for calculi. Hamperl[34] found jelly-like material in the retroperitoneal tissue at autopsy and described a foreign body reaction to sterile urine. More pertinently, Helmke[35] described interstitial infiltration of the perirenal tissues in cases of chronic urinary obstruction (fig. 11). It is possible that the end result of these processes, if chronically induced or often repeated, would be peripelvic and periureteral fibrosis.

[34] Hamperl, A. H.: Vävnadsreaktion ("främmande-Kropps-reaktion") mot slem och urin. Nord. med., **41:** 66, 1949.

[35] Helmke, K.: Die Nierenveränderungen bei Harnstauung, besonders über die Bildung von "Lymphgefäss-und Venezylindern" bei chronischer Harnstauung. Virchow's Arch. path. Anat., **302:** 323, 1938.

SUMMARY AND CONCLUSIONS

Peripelvic extravasation, seen by intravenous urography after ureteral obstruction, is an extreme degree of pelvic backflow and is basically a physiologic phenomenon.

The "edema" fluid often found in the periureteral and peripelvic tissue during operation for ureteral calculi is probably extravasated urine.

Peripelvic extravasation spreads by way of the fornices to the paracalyceal connective tissue, and then through the hilus into the perirenal fat within Gerota's fascia.

Periureteral fibrosis may be due in some cases to previous extravasation of this type.

Since completion of the manuscript, Pawlowski (Pawlowski, J. M., Peripelvic urine granuloma. Am. J. Clin. Path. **34:** 64, 1960) has described in greater detail the tissue changes secondary to peripelvic urinary extravasation.

The author thanks Dr. J. L. MacDonald of Oakland, Cal. and Dr. J. W. Schulte of San Francisco, Cal. for permission to report cases 3 and 4.

DISCUSSION

Dr. Frank C. Hamm (Brooklyn, N. Y.): I enjoyed Dr. O'Conor's beautiful movie and Dr. Hinman's nice presentation. I wish, however, to say a few words about Dr. Lich's and Dr. Howerton's observations on the voiding cystourethrogram.

I did not recognize the title when I first read the program, but the voiding cystourethrogram has been one of our favorite topics recently. I believe it is worthy of considerable emphasis.

May we see the last slide shown by Dr. Howerton, please? There are one or two points in technique that ought to be emphasized.

As you gentlemen know, the Swedes have published a technique for voiding cystourethrography which is a very involved, complicated thing, consisting of a sling that the child sits in, and simultaneous exposures are made anterior from the anteroposterior position and lateral.

Waterhouse has used a very simple technique. It consists simply of putting the child on his back on an ordinary x-ray table and filling the bladder with a dense medium. A dense medium is necessary to give good detail. He has also used the voiding cystourethrogram after excretory urography as a terminal procedure only in cases where one obtains extra-heavy concentration of the dye.

This method has been valuable in diagnosing and differentiating between various types of obstruction at the bladder neck. In the old days we used to think that all bladder neck obstruction in children resulted from the same cause, but now we know that it isn't true—that in addition to having the ordinary bar formation we find valves much more commonly than we did before.

We have collected 11 valves in the last two years just through this method, and correcting the bladder neck obstruction will not give a good result if one has left a valve behind.

(Slide) I would like to go over this slide once again. In our experience this is absolutely typical of a valve. Dr. Howerton mentioned that in his discussion, but I want to emphasize it.

First of all, the bladder outline shows marked trabeculations, and you do have this constriction at the bladder neck which I think threw us off in the old days. We used to think that the obstruction was here. As a matter of fact, one finds a ring-like obstruction in these patients, and we think that it results from hypertrophy of the detrusor. One who is not familiar with this condition will concentrate his attention at the bladder neck.

As a matter of fact, the obstruction is down near the verumontanum, resulting in dilatation of the posterior urethra. In order to relieve this surgically we have experimented with various techniques, first of all the suprapubic approach, which has been very unsatisfactory in our hands. In one child we split the symphysis and made an incision all the way down the posterior urethra in order to remove the valves. It is much easier to remove them with an infant resectoscope.

I would like to emphasize the importance of urethral valves and their discovery by voiding cystourethrography.

Dr. Harry M. Spence (Dallas, Texas): Why is that typical of the urethral valve? I can't see a valve there.

Dr. Hamm: Of course one can't. The valve doesn't show. These valves are very small and many times they can't be seen through the cystoscope. That is another thing that threw us off. Unless one knows that the valve is there, one won't find it with the ordinary cystoscope—at least we don't. Once one knows that the valve is there, then it can usually be found. This, in our experience, is absolutely typical of a valve formation in the male.

Dr. Harry M. Spence (Dallas, Texas): I want to ask some questions of the essayist.

Dr. Howerton, I gathered that you did a substantial number of normal controls from the orthopedic service. Did you find reflux in any of them?

Second, what is this deformity? I may have missed the point completely, but I thought this contraction ring was what you by implication thought was the point of obstruction. I would like to know if it was consistently present throughout the cinefluorography procedure. I don't have cinefluorography. Can I get the same thing by doing just plain films at intervals during voiding?

Third, in the cases in which you did demonstrate reflux with subsequent surgical correction of the obstruction, did the reflux persist or disappear after operation?

Finally, I would like a little better explanation of this poststenotic dilation in the female urethra.

DR. WILLIAM P. HERBST, JR. (Washington, D.C.): I would like to ask two questions, one of Dr. Lich and one of Dr. Hinman, along the lines of what we have just listened to about the bulge in the proximal urethra in the female.

Do you think that could possibly be the result of distal urethral obstruction?

Dr. Hinman, I wonder whether you think the phenomenon you have demonstrated could explain renal area type of pain of a dull, persistent nature.

DR. JOHN K. ORMOND (Pontiac, Mich.): I want to compliment Dr. Lich and his partner on their beautiful demonstration, and I want to ask Dr. Hinman a couple of questions.

As I understand it, this never occurs except in a case of obstruction?

DR. HINMAN: That is the only time we take pictures.

DR. ORMOND: You take a lot of intravenous pyelograms that turn out to be normal.

DR. HINMAN: It has never been seen in that case.

DR. ORMOND: Then how do you explain the fact that you don't get this with the retrograde pyelogram when you inject to the point of filling the pelvis?

DR. THOMAS E. GIBSON(San Francisco, Cal.): I have had one patient recently whom I believe fits into Dr. Hinman's category.

(Slide) This is a preliminary scout film in a man 72 years of age who had 2 days of severe right flank pain. At the top of the picture is a gallstone which is obvious, but the scout film otherwise is negative.

Shortly after coming to the hospital the pain was relieved, and the next morning an intravenous pyelogram was done.

(Slide) Here you see this bizarre looking pyelogram. I thought at first glance the patient had a tumor deformity, but on closer study you can see that it is an extravasation of medium around the renal pelvis, and in the area that Dr. Hinman mentioned was where the leakage probably occurred. The next day, following this intravenous urogram, a retrograde study was done.

(Slide) This shows a normal pyelogram. At the time the cystoscopy was done a small stone was removed from the bladder, presumably a ureteral stone that had been passed down from this kidney. The extravasation apparently occurred as a result of temporary acute obstruction caused by the stone.

(Slide) A final pyelogram was done 2 weeks later, and was again normal. This sort of leakage might possibly be one of the causes of Ormond's disease.

Speaking briefly about sperm granuloma, I saw a patient not long ago who had an egg-like swelling in his left groin, which developed after he had been kicked in the groin by a mule. A general surgeon thought it was a hernia, but on opening the inguinal canal he found that the swelling was in the vas. It was a sperm granuloma about the size of a Texas pecan.

DR. WILLARD GOODWIN (Los Angeles, Cal.): I would like to speak of Dr. Hinman's paper.

Some years ago we saw a patient with similar extravasation. At operation we found that he had a cancer of the stomach obstructing the ureter. At autopsy the cancer of the stomach obstructed the lymphatics. We inferred that because the lymphatic safety valve was closed by the cancer, this caused the extravasation.

Dr. Hinman said this is a physiological thing. How often does it happen, if it is physiological; and does it have anything to do with lymphatic obstruction? Also, does it make any difference whether the obstruction in the urinary tract is high or low?

DR. MYRON H. NOURSE (Indianapolis, Ind.): I want to substantiate the findings in Dr. Hinman's paper. This is in a normal patient, showing what Dr. Hinman mentioned.

(Slide) I wonder if this is what Dr. Hinman was referring to concerning the use of compression during intravenous urography, where evidence of the dye is demonstrated outside the renal pelvis.

(Slide) This slide is the intravenous pyelogram made 2 weeks later of the same patient without the use of compression. It is normal and no dye is seen outside of the renal pelvis.

DR. BEN D. MASSEY (Pasadena, Cal.): I wish to make one or two comments in regard to Dr. O'Conor's paper. I think that half the number of his cases on reconstruction of the deliberately interrupted vas would be a fairly accurate estimate of the series we have performed.

When interruption of the vas has occurred in early life, reconstruction is almost certain to fail.

In one case, we had a patient who had bilateral congenital hernia operated on at the age of three or four years. The vasa had been interrupted at the inguinal ring. Exploration revealed that each vas was not dilated proximal to the point of interruption, as is usually found when the vas has been interrupted after puberty. In this case, the distal vasa were almost completely obliterated. Reconstruction was unsuccessful.

Reconstruction of the vas in its proximal tortuous portion is difficult and success is not great.

We have used all types of sutures—000000 silk, fine cotton, and we are now using 00000 chromic. They all seem to work with equal success.

We have always splinted the vasal lumina 7 to 9 days and we have used stainless steel rather than gut. At our request, Davis & Geck very kindly made us a double armed 0000 monostrand suture of stainless steel wire on straight needles. These are less traumatic and can be passed an inch in each direction, always bringing them out through the vasal wall and scrotum so that the wire acts not only as a splint but also causes approximation by pressure of the cut ends. We have not put sutures into the vas itself, but have tried to stay in the adventitial area.

Dr. John K. Lattimer (New York, N.Y.): I have a question for Dr. Lich. In the enlarged movie frames which you have shown us of small female children with urinary infections, what percentage showed contracture of the bladder neck? Was trabeculation of the bladder correlated with this contracture defect? In other words, when you had this defect did you see trabeculation in the bladder?

Dr. Hinman, what happens when the urine is infected and extravasation of urine from a calyx occurs? We have seen it only in uninfected cases, and we wonder what the febrile reaction might be if the urine was infected.

Dr. Vincent J. O'Conor (Chicago, Ill.): In answer to Dr. Massey, it is true that when the vasa are ligated during a hernia operation, especially in youngsters, it makes the procedure of reanastomosis difficult because the point at which the vas is ligated is usually just where it bends and goes posteriorly at the internal inguinal ring. The vas is caught in the purse-string suture as a rule which is used to close off the hernial sac.

I think my figures showed that out of six of these patients I had two successful results with pregnancies, and that is better than my average in any of the other groups.

The point that Dr. Massey made is truest of all, that if we are going to reunite the vasa successfully, as a rule, they have to be ligated far enough down the vas—that is, away from the globus minor, to allow us to have a straight vas rather than in the tubular portion close to the epididymis. Those are the ones in which we have the poorest results.

Dr. Robert Lich, Jr.(Louisville, Ky.): There are several points that I would like to emphasize:

First, the slides that Dr. Howerton showed were spot films measuring about 3 by 4 inches with four on an 8 by 10 inch plate and usually eight are exposed in seven seconds. These are not movie strips.

Second, this technique is quite different than any of the existing methods, to our knowledge, of cystourethrography. The initial exposure is made immediately after the child initiates voiding so that the film records the urethra and bladder neck at the height of voiding pressure. If the films are not exposed at the height of intraurethral pressure, the characteristic "acorn deformity" which is diagnostic of vesical neck obstruction will not be shown. The "acorn deformity" we believe, is due to poststenotic dilatation of the urethra. It is the identical picture of poststenotic dilatation in the arterial system.

Third, the image intensifier permits the entire urinary tract to be monitored and films are exposed as pathology is observed, i.e. ureteral reflux, hydronephrosis, etc.

Fourth, we have never demonstrated the "acorn deformity" in the urethra of normal children. Furthermore, it is extremely interesting that in these normal children a post-cystourethrographic cystitis never occurred while in the group with vesical neck changes there was a high percentage of postcystourethrographic infections. Seemingly vesical neck obstruction, irrespective of degree, is closely associated with urosepsis.

Dr. Spence inquired about our attitude toward ureteral reflux. We have surgically corrected this condition along with the revision of the vesical neck when the reflux was marked, but we are not clear as to the precise indications for surgical

correction. At present we have a significant series under observation and hope within a year or two to have a definite answer to this perplexing problem.

On repeated occasions we have recystoscoped these children when the cystourethrogram demonstrated a vesical neck contracture and still it was not evident cystoscopically. Apparently unless the obstructive lesion is far advanced the cystoscopic picture is not evident. It is also true that the degree of vesical trabeculation is a rough index of bladder neck obstruction, but unless there is relatively marked obstruction or of long duration, trabeculation will not be evident. Furthermore, there is not definite correlation between trabeculation and reflux.

Dr. Leadbetter asked that I discuss the last slide that Dr. Howerton showed. The obstruction seemingly was in the posterior urethra and we thought it to be due to urethral valves. This was confirmed at surgery. Therefore, the vesical neck was not disturbed at the time of surgery, but postoperative cystourethrograms continue to show vesical neck narrowing. This narrowing is not marked and there is no residual urine and the child is clinically well. If I remember correctly, Dr. John Emmett once said that valves were little more than the elevated cristae occasioned by the related vesical neck. This patient would suggest the validity of this statement.

Dr. Frank Hinman, Jr. (San Francisco, Cal.): Dr. Herbst asked whether this could cause persistent renal pain. I rather doubt it. I would compare this with presacral pneumography, which is not a painful procedure, yet the gas is distending the perirenal tissues. Or, compare it with patients who have urinary extravasation in the lower abdomen. That is not painful. So, I don't think the extravasation, per se, is painful, rather it is the distension of the pelvis. If anything, extravasation would relieve the pain because it allows relief of that distension.

Dr. Ormond asked why this does not occur with the retrograde film. It does occur independently; in fact, Fuchs, who first described this back in 1931, found it on a retrograde film. The patient had tuberculosis, and Dr. Fuchs thought perhaps his manipulation had something to do with it.

Why you don't see it on the immediate retrograde film may be due to the fact that you don't overdistend it at this time, and therefore you don't reopen the pathway. Other than that, I don't know why you don't see it. Perhaps there are things in the calyceal mechanism which we don't understand.

Dr. Gibson's case is typical of this, and I think if you will look at your intravenous urograms you will occasionally see this condition. The last patient I showed was picked up just because I was interested in it. The radiologist had not seen it. One can find this phenomenon 17 times in the literature. It is relatively uncommon, but I think we can find it if we look for it.

Dr. Goodwin's case of carcinoma of the stomach—the television injury—I am familiar with. I rather think it was coincidental in light of the observations which we have made since that time. The lymphatic obstruction I do not think makes much difference one way or another. I think the lymphatics play a relatively small role in backflow. Actually, there is lymphatic pick-up too. It is picked up in the periureteral tissues.

Dr. Goodwin asked whether high or low obstruction makes any difference. In our cases, some were high and others were low. In the literature most of them are low. He asked that question because of experimental work in his laboratory by Rodriguez (which I hope will be published as it is most interesting) showing that if the obstruction were low there was more periureteral edema and reaction than if the obstruction were high.

Dr. Charnock asked why these occur mostly about the lower pole. The reason is that these are patients who are sitting up in bed or who are ambulatory. If we had them upside down, it probably would extravasate in the upper regions, inside Gerota's fascia.

Dr. Nourse, there have been five previous cases with compression. Olsson in Sweden found these when he was studying patients with tuberculosis. This was incidental. I am sure tuberculosis is not necessary for this phenomenon.

Dr. Lattimer asked about infected urine. We have not seen any with infected urine. It may very well be that patients with infected urine have a reaction which closes off this fornical mechanism. I might just cite Guze and Beeson's experiment in which they took two series of animals and ligated the ureter. To one they

gave cortisone and to the other they didn't. They found that if they gave cortisone they did not get the hydronephrosis which they got in the control animals with the ligation.

A possible explanation for this is that cortisone prevented a fornical inflammatory reaction (we know an acute obstruction causes an intense reaction in this area) and therefore allowed a backflow mechanism to continue. Perhaps, also, infection interferes with this backflow mechanism.

PRESIDENT NESBIT: One question, Dr. Hinman. Do you now condemn the use of pressure for excretory urography?

DR. HINMAN: I think this extravasation is a physiologic phenomenon. It does not make much difference whether it occurs or not, as long as you don't operate on the patient because of it.

ANTERIOR NEPHRO-URETERECTOMY: ADVANTAGES AND LIMITATIONS OF A SINGLE INCISION

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Nephro-ureterectomy through a single incision is neither new nor unique, but it has found little favor. Repeated admonitions to include the ureterovesical juncture and to avoid the peritoneal cavity have encouraged the use of two separate incisions in *all* types of cases.

In 1953, DeWeerd and I expressed some enthusiasm for anterior extraperitoneal removal of the kidney and entire ureter after trying a modification of the Cherney incision in two cases. It seems apropos to evaluate the anterior approach after further clinical experience and to compare it with the conventional types of exposure.

MATERIAL

From May 1951, to January 1960, 64 nephro-ureterectomies were performed through single incisions. This group included 50 modified Cherney incisions, seven midabdominal ones and seven anterior extensions of incisions in the flank. During the same period, 60 nephro-ureterectomies were done through two separate incisions. Since the two groups are almost equal numerically, they permit some interesting comparisons.

OBSERVATIONS

Age and sex. Males predominated in both categories, but especially in the one employing two incisions (table 1). There were relatively few nephro-ureterectomies in young adults. More than 60 per cent of all the operations were performed in patients 50 years of age or older, with a slight preponderance of two incisions. One incision was used in most of the children. Their size and the benign nature of their lesions no doubt were factors in this choice.

Indications. As shown in table 2, the percentage of lesions that were benign was greater in the group with one incision than in the group with two incisions. Children with megaloureter or reflux accounted for the difference. Carcinomas in the one-incision group were primary in the lower half of the ureter or in the bladder, while those in the two-incision group originated in the renal pelvis or upper part of the ureter.

Since the true nature of many lesions was uncertain prior to operation, the site of the filling defect or obstruction dictated the route of exploration and will continue to do so in the future. In retrospect, at least 10 (16.7 per cent) of the nephro-ureterectomies performed through two incisions could have been done safely and satisfactorily by the anterior method.

Extent of ureterectomy. There were more subtotal ureterectomies with single incisions than with two incisions (table 3), but only because of the larger number of benign diseases in the one-incision group. The importance of including the orifice when dealing with papillary tumors is common knowledge. Only three patients in the entire series had carcinoma and subtotal ureterectomy. Each was more than 70 years of age.

Three ureterovesical obstructions had to be excised and studied histologically before anticipated malignancy could be excluded. In one case the obstructed ureter drained into a vesical diverticulum. In two others, large ureteroceles were responsible for the obstruction. Partial cystectomy was justified in these six benign problems.

But in four other cases of benign disease, removal of the ureteral orifice had no diagnostic or therapeutic value. All of these patients were treated through two incisions. If the pathologic process is obviously nonmalignant, intramural or juxtavesical ligation of the ureter simplifies the operation tremendously, lessens morbidity and appears to be the technique of choice.

Duration of operation. Despite varying roles assigned to surgical assistants, 52 per cent of the patients in the one-incision group were off the operating table within 90 minutes, while 35 per cent of the group treated through two incisions had their operation completed within the same time. But not all situations were identical. As noted previously, there were more subtotal

TABLE 1. *Age and sex of 124 patients*

Age, Years	One Incision			Two Incisions			Total	
	Male	Female	Both	Male	Female	Both	No.	Per cent
<10	6	11	17		2	2	19	15.3
10–29	4	2	6	3	4	7	13	23.4
30–49	4	2	6	4	6	10	16	
50–59	5	4	9	12	3	15	24	
60–69	14	5	19	15	4	19	38	61.3
70–79	5	2	7	7		7	14	
Total	38	26	64	41	19	60	124	100.0

TABLE 2. *Indications for 124 nephroureterectomies*

Lesion	One Incision	Two Incisions	Total
Carcinoma			
Pelvis		25	25
Ureter	22	7	29
Bladder	4		4
Combined	4	5	9
Subtotal	30 (46.9%)	37 (61.7%)	67
Benign			
Dilatation	30	17	47
Calculi	4	1	5
Tuberculosis		5	5
Subtotal	34 (53.1%)	23 (38.3%)	57
Total cases	64	60	124

TABLE 3. *Extent of ureterectomy in 124 cases*

Type of Ureterectomy	One Incision	Two Incisions	Total
Total (including orifice)	33	41	74 (59.7%)
Subtotal	31	19	50 (40.3%)
Intramural	16	8	
Juxtavesical	15	11	
Total cases	64	60	124

ureterectomies in the first group. Concomitant procedures, such as prostatectomy or herniorrhaphy, obviously prolonged some operations.

Further time comparison was confined to operations that included removal of the ureteral orifice without any special therapeutic adjuncts. Thirty patients qualified in the one-incision group and 36 in the two-incision group. The average duration of the operation was 93 minutes when one incision was employed, and 126 minutes when two incisions were made.

Factors other than changing the patient's position may have contributed to this time differential. Varying technical demands could not be evaluated as readily as the patients. According to the standards of life insurance companies, 40 per cent of the individuals with one incision and 35 per cent of those with two incisions had some degree of obesity. The incidence of adiposity, therefore, did not favor the group with one incision.

Six different surgeons operated on patients in this series. No doubt there were time-consuming variations in individual techniques. It is noteworthy, however, that one surgeon performed 65 per cent of all the operations in both groups. When only his cases were compared, the additional operating time for two incisions averaged 28 minutes.

Hospitalization. Some patients in both categories left the hospital 1 week after operation. Others remained for almost a month. In a few instances, hospitalization was prolonged because of radiation therapy or unrelated operations. The average stay was 13 days in both groups. Total

TABLE 4. *Complications in 124 nephroureterectomies*

Type	One Incision (64 Cases)	Two Incisions (60 Cases)	Total (124 Cases)
Fatal embolism		1	1
Phlebothrombosis	2	1	3
Cardiac arrest	1		1
Severe ileus	2		2
Delayed shock		1	1
Oliguria		1	1
Wound infection	5	7	12
Wound separation		1	1
Incisional hernia		2	2
Pneumonitis	2	2	4
Pyelonephritis	1		1
Enteritis	1		1
Pancreatitis	1		1
Parotitis	1		1
Gout		1	1
Total complications	16 (25%)	17 (28.3%)	33 (26.6%)

ureterectomy required an average of 4 more days of hospitalization than did subtotal ureterectomy.

Complications. Significant complications followed 25 per cent of the single incisions and 28 per cent of the double incisions (table 4). Phlebothrombosis in a lower extremity occurred in both groups. Unfortunately, not all instances of thrombosis were recognized; one patient died of massive pulmonary embolism before phlebothrombosis was suspected. The others recovered after anticoagulant therapy.

The one cardiac arrest was detected immediately because the peritoneum had been opened to expedite the dissection and aortic pulsations ceased abruptly. Prompt thoracotomy and cardiac massage resulted in full recovery. The peritoneum was opened deliberately for technical reasons in 11 cases. The only unfavorable sequela was persistent ileus in two of these.

Prolonged operating time may have been a contributing factor in the patient with delayed shock and the one with suppression of urine. Both operations were done through two incisions and each required 2½ hours.

Incisional complications occurred twice as often when two openings were made. Obviously this method doubled the opportunities. The only hernias were in midline incisions, but any type of exposure must be considered vulnerable.

The other acute infections and the metabolic disturbance were not reflections on any specific type of treatment for they are known to occur in the absence of surgical procedures.

Types of incision. When two incisions were employed, the flank component often was accompanied by partial resection of the twelfth rib. The lower abdominal incisions included the McBurney type, oblique division of the muscles, and (most commonly) midline ones. All seemed to be satisfactory when employed properly.

Anterior extensions of flank incisions were limited by the rectus muscle and by the position of the patient on the operating table. Adequate exposure of the bladder was impossible in most adults.

Single midabdominal incisions included midline, rectus, paramedian and lateral rectus versions. This approach was especially useful for unidentified masses in very young patients, but transperitoneal exposure of the kidney proved to be extremely difficult in obese adults.

The modified Cherney incision was the most versatile and seemed to cope with obesity better than did the others. Its success depends upon several cardinal steps that warrant reiteration.

SPECIAL TECHNIQUE

The patient should be supine with an empty bladder and have the lumbar region over the break in the table so that hyperextension can be employed if desired. A sandbag under the ipsilateral side of the thorax helps to expose the

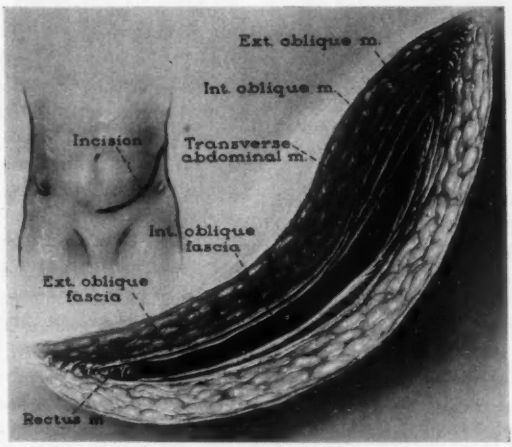

FIG. 1. Single incision for total nephro-ureterectomy. Aponeuroses of external and internal oblique muscles and transverse fascia are incised. Muscles in flank are divided as far as necessary. Anterior sheath of rectus is opened when more exposure is needed.

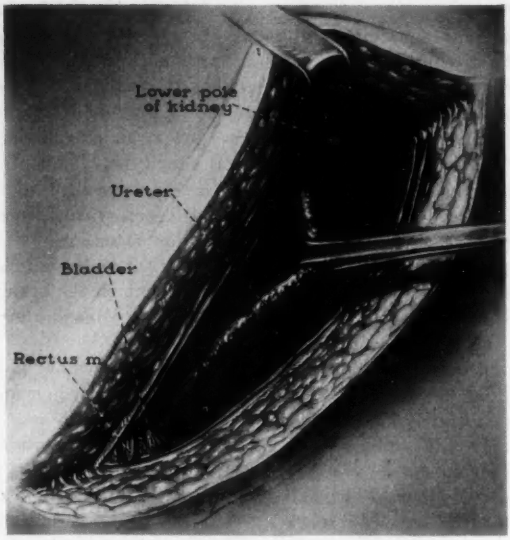

FIG. 2. Ureter, adjacent portion of bladder and lower pole of kidney exposed by freeing and retracting peritoneum medially.

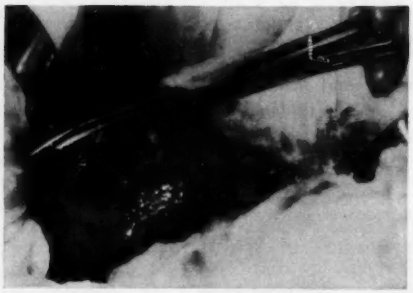

FIG. 3. Kidney and vascular pedicle exposed through extension of anterior incision.

costovertebral angle. The incision is started over the corresponding rectus muscle about 2 finger-breadths above the symphysis pubis and curves upward medial to the anterior superior spine of the ilium where it again curves toward the costovertebral angle (fig. 1). The initial length depends upon the portion or amount of ureter that requires exploration.

After incising the aponeuroses of the external and internal oblique muscles, the transverse fascia is divided and the inferior epigastric vessels are ligated. Retraction of the rectus muscle promptly exposes the perivesical space. Starting in the pelvis, peritoneum is stripped from the overlying muscles and retracted medially. With peritoneum out of the way, contiguous muscles in the flank can be cut quickly with impunity. Blunt dissection and further medial retraction soon expose most if not all of the ureter (fig. 2).

If better exposure of the bladder is needed, the sheath of the rectus is incised transversely and all or part of the rectus tendon on that side is severed just above the pubis. By extending the incision and dividing both rectus tendons, the opposite side of the bladder was exposed in a few special instances. During the closure the tendons are sutured to the rectus sheath instead of the pubis.

Size, position and degree of fixation of the kidney can be determined readily by palpation once Gerota's fascia has been opened from below. This appraisal should be made before the incision is extended very far into the flank for it will indicate the feasibility of continuing via this approach. In only one instance did it seem prudent to remove the kidney through a secondary conventional flank incision rather than through further extension of this type of exposure.

The original incision can be extended to the costovertebral angle if necessary. Partial resection of the twelfth rib can be included without difficulty. Much shorter extensions usually suffice. The upper pole of the kidney must be

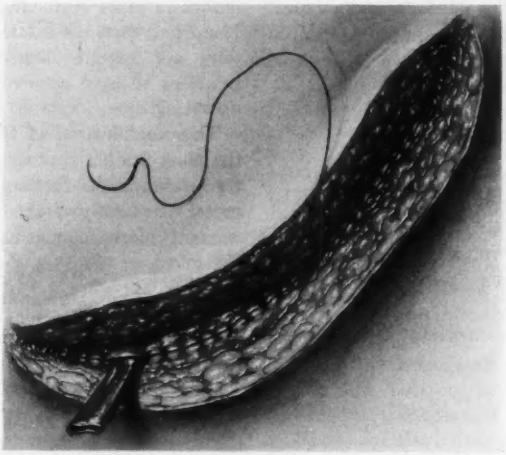

FIG. 4. Closure of incision with two layers of chromic catgut sutures in muscles and fascias after insertion of Penrose drain.

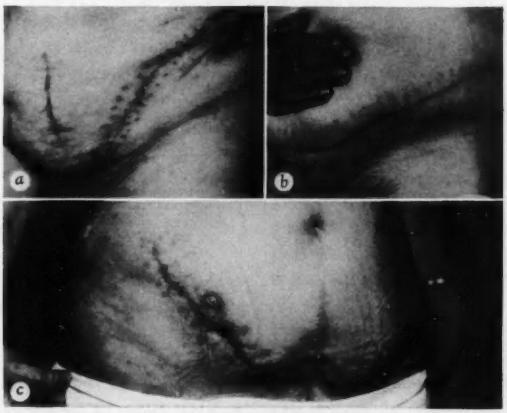

FIG. 5. Extent of incision in man who weighed 240 pounds (*a*), man who weighed 170 pounds (*b*), and woman who weighed 163 pounds (*c*).

freed blindly but this often is true with all of the more common incisions. The renal pedicle can be exposed extremely well despite the overhanging thorax (fig. 3). Indeed, the exposure far surpasses that which can be achieved transperitoneally because all impedimenta are retracted medially or anteriorly and the distance from skin to pedicle is much shorter.

If intraperitoneal exploration seems advisable, it can be accomplished promptly and efficiently and can be as extensive as may be indicated.

The incision is closed with two layers of chromic catgut in the muscles and aponeuroses (fig. 4), plain catgut in the subcutaneous fat and nonabsorbable sutures in the skin. Drains can be brought out at either or both ends of the incision.

The length of incision necessary in a man who weighed 240 pounds is shown in figure 5*a*. The abdominal and lumbar scars are from previous operations on the same kidney. Less obese patients required less exposure. The male patient shown in figure 5*b* weighed 170 pounds. Shorter incisions are usually adequate for the right kidney. The female patient shown in figure 5*c* weighed 163 pounds, but required a remarkably short incision. Each of these patients had total

nephro-ureterectomy. The third also had a vesical tumor that necessitated removal of a substantial amount of her bladder. Duration of these three procedures averaged 95 minutes.

CONCLUSIONS

Both types of nephro-ureterectomy have been and should be employed advantageously. The combination of separate flank and lower abdominal incisions is obviously best for suspected primary tumors of the renal pelvis and upper end of the ureter.

A single incision is especially adaptable to lesions in other segments of the ureter and the bladder. It does not entail any increased hazards, does not require longer hospitalization, and promises to save approximately 30 minutes of operating time.

This modification of the Cherney incision is the most flexible approach to the upper urinary tract, affords the best exposure of most of the ureter (especially if the patient is obese) and warrants more frequent usage.

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ANTERIOR APPROACH TO UPPER URINARY TRACT SURGERY

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For years it has been taught that the anterior approach for removal of renal tumors is theoretically better than the traditional flank approach generally used by urologic surgeons, because the vascular pedicle of the kidney can be divided before handling the tumor. However, in truth, this relatively unfamiliar approach is seldom used and only by a few urologists. Experience in surgery on the renal artery in hypertensive patients, where the anterior transperitoneal approach is mandatory for proper exposure of renal vessels and aorta, led to my adoption of this approach for most types of surgery on the upper urinary tract. It has many advantages over the classic flank approach and has now been used in more than 250 operations of various types, except open renal biopsy, emergency nephrostomy, and uncomplicated ureterolithotomy. The crucial part of any renal operation usually involves the medial aspect of the kidney, and the anterior approach provides the most direct and best exposure of this part without necessitating mobilization of the kidney.

TECHNIQUE

For a unilateral renal operation the patient is placed supine on the operating table with the kidney rest slightly elevated at the level of the upper lumbar spine. The body is turned slightly by means of a rolled towel or sandbag so that the operative site is a little higher than the rest of the abdomen.

A subcostal incision (fig. 1, *A* and *B*) is utilized for all operations on either kidney or its vascular supply. Starting laterally, near the tip of the twelfth rib, it runs medially about 1 inch below the costal margin, usually ending 1 or 2 inches below the xiphoid. For obese patients it can be extended across the midline to give more room. The external oblique muscle is divided, the internal oblique muscle is split between its fibers, and the transversus muscle may be split or divided. The rectus muscle is transected and the anterior peritoneum is opened for the full length of the incision. The actual angle of the incision will vary according to the configuration of the costal margin, but, except in anomalous situations, the renal artery and vein are usually at the level of the lower part of the first lumbar vertebra, which should project about 2 inches below the level of the xiphoid. When the artery and vein are properly visualized, renal surgery is easier and less hazardous.

A midline incision (fig. 1, *B*) with the patient flat on the table is used for operations on both kidneys, renal arteries, ureters, or adrenals, or when laparotomy or other abdominal surgery is anticipated simultaneously. The incision can be as long as necessary and is generally more suitable than a transverse upper abdominal incision for these diverse procedures.

Although one can stay out of the abdominal cavity by carefully freeing the peritoneum under the transversus muscle and retracting the peritoneum and the organs within,[1, 2] it is often easier and more advantageous to approach the kidney transperitoneally. The intestines are retracted and packed off medially, and for this purpose a damp towel folded once lengthwise and rolled up at one end is useful. As it is inserted deeper and deeper for packing off the intestines, it is gradually but not completely unrolled, the reinforced end serving as a firm anchor. Self-retaining retractors, such as the Smith* retractor, can be used to considerable advantage in holding the exposure.

For an operation on the right side (fig. 1, *C*), the posterior peritoneum is cut transversely over the middle of the kidney to expose its hilus and renal vessels. The vena cava comes into view and can be readily dissected free of its surrounding fibrous tissue (fig. 2). The duodenum retracts medially along with the hepatic flexure of the

* Smith, D. P.: An anchored mechanical retractor. Am. J. Surg., **83:** 717–720, 1952. The retractor is distributed by Codman & Shurtleff, Boston, Mass.

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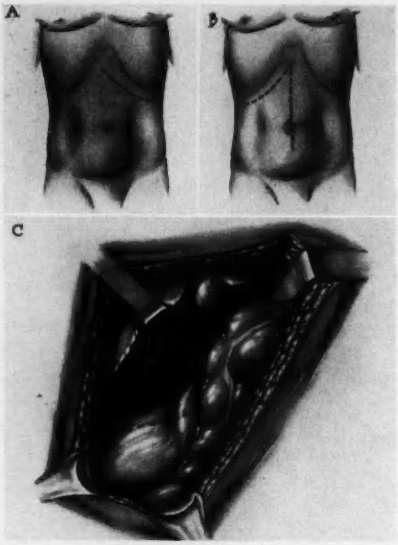

FIG. 1. Anterior subcostal incision (*A* and *B*) utilized for surgery on either kidney or its vascular supply. Midline incision (*B*) may be used for bilateral renal or adrenal surgery or simultaneous laparotomy. *C*, subcostal transperitoneal approach to right kidney; liver is retracted cephalad and hepatic flexure of colon is retracted medially. Dotted line shows contemplated transverse incision of retroperitoneum over hilus of right kidney and second part of duodenum. (Courtesy of Ethicon, Inc.: "The Surgical Correction of Renal Hypertension"; and Frank Robinson, artist (sketches from Eugene F. Poutasse).)

colon; in fact, if more exposure is necessary, these structures may even be retracted to the left of the aorta. In some patients who have had intra-abdominal disease, there are adhesions between the intestines and gallbladder or liver that have to be separated to expose the retroperitoneum.

For an operation on the left side, the retroperitoneum is cut vertically just lateral to the splenic flexure and descending colon. As the colon is retracted medially, Gerota's fascia is exposed and may be opened in any desired manner to reveal the kidney (fig. 3). There is almost always more fatty tissue surrounding the left kidney than the right. The lateral attachments of the splenic flexure to the spleen or its pedicle are also divided and, as the bowel is retracted further medially, the renal hilus and vessels are brought into view. The renal pelvis can be found by dissecting the fat adjacent to the lower pole of the kidney, locating the ureter, and following it upward toward the renal hilus. The renal vein is lifted slightly with a vein retractor, although it is often not in the way, and the full length of the renal pelvis can be exposed for a long incision way up inside the hilus of the kidney (fig. 4)—even further than is possible through the classic flank incision.

When there is inadequate exposure of the upper pole of the left kidney or adrenal gland, the spleen is retracted medially by reaching over it with the left hand, cutting its lateral peritoneal attachments, and lifting the spleen and splenic pedicle with the tail of the pancreas out of the abdomen, thus exposing the entire left retroperitoneal space below the diaphragm.

An alternate approach to the left kidney, especially useful from a midline incision, is to make an opening directly through an avascular part of the mesentery of the splenic flexure of the colon to expose the left renal hilus. This can be used for surgery on the left renal artery, removal of a pelvic stone, or excision of a small adrenal tumor.

Another approach to either renal artery, but useful only from a midline incision, consists of dissecting the mesentery of the small intestine over the aorta and vena cava upward until the renal vessels are exposed and can be followed

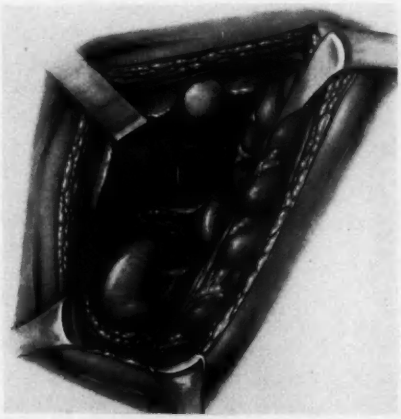

FIG. 2. Subcostal, transperitoneal approach to right kidney; retroperitoneum and Gerota's fascia opened to expose right kidney and renal vein. Lateral edge of vena cava is just visible under duodenum. Hepatic flexure of colon is retracted medially. (Courtesy of Ethicon, Inc.: "The Surgical Correction of Renal Hypertension"; and Frank Robinson, artist (sketches from Eugene F. Poutasse).)

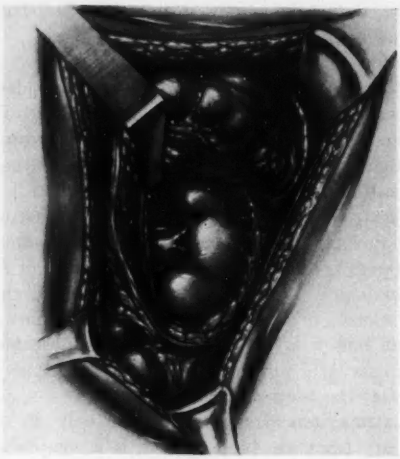

FIG. 3. Subcostal transperitoneal approach to left kidney; splenic flexure and descending colon are retracted medially; their lateral attachments have been cut. Gerota's fascia is opened to expose left kidney and its vascular pedicle. Spleen is visible in upper right corner of sketch. (Courtesy of Ethicon, Inc.: "The Surgical Correction of Renal Hypertension"; and Frank Robinson, artist (sketches from Eugene F. Poutasse).)

laterally to the kidney. For this, good retraction of intestines and mesentery is essential, preferably by a Smith self-retaining retractor. This exposure is limited by the root of the mesentery and its vessels, but it is useful for surgery on the renal artery, in which it is essential to expose the aorta—for example, the placing of an aortic-renal artery by-pass graft. It is also excellent for the dissection of lymph nodes along the aorta and both renal pedicles.

With the anterior transperitoneal approach it is not necessary to dissect and mobilize the kidney in order to remove pelvic or calyceal calculi, to perform surgery on the renal artery or adrenal gland, or to repair the ureteropelvic juncture (fig. 5). Careful dissection of the renal pedicle fat reveals the renal pelvis and vein; the renal artery always lies under the renal vein and can be palpated before it is visualized by retracting the renal vein (fig. 6). With these structures in view, extensive procedures can be done without damage to the vena cava, duodenum, or aorta (fig. 7).

For partial nephrectomy, the kidney is mobilized by sweeping the hand around the kidney, freeing it from the perirenal fat, and rotating and lifting the kidney so that the desired part presents at the level of the abdominal incision, just as though the fundus of the gallbladder was being dissected from the liver (fig. 8). The anterior approach provides a distinct advantage in identifying and ligating the segmental artery that supplies the portion of the kidney to be removed, as well as making it easier to rotate either pole of the kidney into the incision.

Exploration of a kidney for a space-filling lesion suggestive of tumor is actually facilitated

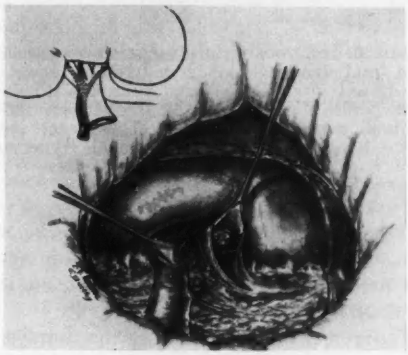

FIG. 4. Left pelviolithotomy by anterior subcostal transperitoneal approach, viewed from opposite side of patient for better look into pelvis and calyces. Vein retractors hold renal vein and hilus for long incision of pelvis inside of kidney. Insert shows usual relationship of renal vein, artery, and pelvis. Note that kidney has not been mobilized.

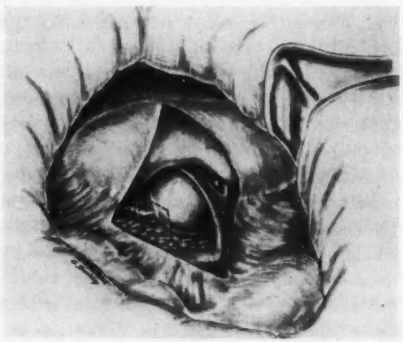

FIG. 5. Anterior subcostal transperitoneal exposure of congenital hydronephrosis of right kidney, viewed from opposite side of patient. Note that kidney has not been mobilized and only a short retroperitoneal incision is necessary to expose ureteropelvic juncture, ureter, renal vein, and vena cava.

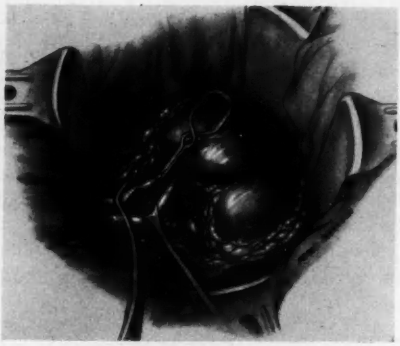

FIG. 6. Left renal artery prepared for excision of a focal stenotic lesion. Renal vein is retracted downward after left adrenal vein was divided. Note blades of Smith self-retaining retractor used to hold exposure. (Courtesy of Ethicon, Inc.: "The Surgical Correction of Renal Hypertension"; and Frank Robinson, artist (sketches from Eugene F. Poutasse).)

by the anterior transperitoneal approach because the lesion can be palpated before opening the retroperitoneum and its nature usually determined immediately.

For complete nephrectomy, the retroperitoneum is opened and the renal artery divided first so that the kidney will not become engorged with blood. The renal vein is then divided; on the left side the vein can be ligated easily, but on the right it is often too short and wide to ligate readily and it is secured better with a continuous suture of arterial silk. In nephrectomy for tumor, the kidney with its perirenal fat intact is removed, leaving the entire retroperitoneal space clear of all tissue.

If the occasion for nephropexy arises, an effective if not the best method is available through the anterior transperitoneal approach. The kidney is pushed upward to the desired position, the retroperitoneum is incised just below the kidney, and the upper peritoneal edge is sutured firmly to the psoas and adjacent muscles and fascia, thus holding the kidney in a firm sling. Care must be used to avoid the ureter medially.

One small but helpful point for gaining better exposure when the stomach is full of gas is to cause the patient to regurgitate by manually squeezing the stomach, forcing gas up the esophagus, or to have the anesthetist pass a Levin tube and aspirate the contents of the stomach.

In closing, the kidney, if it has been mobilized, is replaced in its fossa. On the right side, the retroperitoneum is closed with interrupted or continuous suture. On the left side, the splenic flexure and descending colon are fastened to the lateral peritoneal wall by interrupted sutures. Actually, when the urinary tract has not been opened and the kidney has not been lifted from its bed, it is often not necessary to reconstruct the retroperitoneum; the intestines are simply restored to their normal position. Closure of the abdominal incision is done by the method that the surgeon prefers. Through-and-through closure of all muscle layers and fascia with interrupted stainless steel wire or chromic catgut sutures is used at the Cleveland Clinic.

Extraperitoneal drainage, used only if the urinary tract has been opened, is accomplished

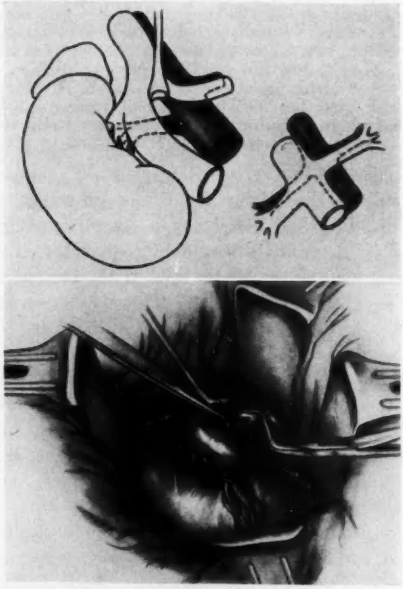

FIG. 7. First part of right renal artery prepared for endarterectomy. Vena cava is retracted laterally, left renal vein cephalad. Angled arterial clamp is applied to aorta, and small arterial clamp prevents backflow into opened part of renal artery. Insert shows normal relationship of vena cava and renal veins to aorta and renal arteries (shaded), and method of retraction for exposure of first part of right renal artery. (Courtesy of Ethicon, Inc.: "The Surgical Correction of Renal Hypertension"; and Frank Robinson, artist (sketches from Eugene F. Poutasse).)

FIG. 8. Segmental resection, lower pole of right kidney, by subcostal transperitoneal approach. Kidney rotated and lifted up into incision; segmental arterial branch divided and capsule peeled back.

by inserting a cigarette drain through a stab wound just below the twelfth rib and lateral to the incision, guiding the drain extraperitoneally to the point where the pelvis or kidney was opened. The retroperitoneum is carefully closed, covering the drain completely. Intraperitoneal leakage of urine has not been noted in any of these patients, even after, for example, a pelviolithotomy by the anterior transperitoneal approach; perhaps the accurate closure of the renal pelvis that can be done via this approach contributes to quick healing. A nephrostomy tube can be inserted extraperitoneally just like the drain and, after locating a convenient calyx, pushed through a small incision in the cortex into the renal pelvis for the temporary diversion of urine or the topical instillation of antibiotics in an infected kidney.

General anesthesia is preferred and has been employed in all patients; it usually consisted of a combination of thiopental sodium, nitrous oxide, relaxants, and intubation.

POSTOPERATIVE CARE

A Levin tube was passed in practically all patients while they were under anesthesia and left on suction until peristalsis was audible, usually within 24 hours. Then the suction was stopped and clear fluid permitted; the tube was removed if no abdominal distension occurred within a few hours. Thus, late postoperative ileus was encountered rarely in any of these patients. In "clean cases," no antibiotics were used; they were reserved for those patients who had infections or in whom signs of infection developed. No peritonitis occurred, even in patients who had urosepsis, and the only wound infections of note were a few subcutaneous wound abscesses.

ADVANTAGES

The patient benefits from the use of the anterior transperitoneal approach for surgery on the upper urinary tract because he is in a more natural position during the operation. The immediate postoperative discomfort is greatly decreased and the incidence of postoperative ileus is small compared with that experienced by patients who undergo renal surgery by the classic flank route. Furthermore, there is practically none of the late intercostal nerve pain, which is so often present after the classic approach. Thus far, wound hernias have not occurred and there are probably several reasons for this. The abdominal muscles are heavier on the front and a better closure is possible, compared with the difficulties encountered in the classic flank incision, where the muscles are sutured to the inferior edge of the twelfth rib, or its bed if it has been removed. Furthermore, the intercostal nerves are not divided; thus there is no late weakness of the abdominal muscles. The use of a lateral stab incision for drainage means the anterior incision can be closed completely.

There are many advantages for the surgeon: The anterior transperitoneal approach provides a direct route to the renal vessels and pelves without the need of mobilization of the kidney, because the renal mass is not in the way. Direct control of bleeding is possible and there is less danger of unexpected hemorrhage, because the exposure reveals the blood vessels better than the classic flank incision. There is much less back bending and blind dissection by the surgeon. Bilateral renal exploration and operations are possible, such as nephrectomy on one side and partial nephrectomy or excision of a specimen for biopsy on the opposite side.

Those who have had the opportunity to observe anterior transperitoneal renal surgery have been impressed with the good exposure and the lack of bleeding and trauma to the kidney. A situation for which this approach is especially useful is in a patient who already has had one or more procedures performed on the kidney

through the classic flank approach. Scar tissue makes the latter approach formidable, but it is surprisingly easy, for example, to remove a recurrent renal calculus transperitoneally.

The surgeon can stand on either side of the table, but usually for operations on the renal pelvis I find it easier to work on the side opposite the kidney being operated on so that I can look directly into the pelvis and calyces by retracting the renal hilus.

For staghorn calculi the renal pelvis is opened far up inside the hilus of the kidney. The major, pelvic portion of the calculus may have to be broken off from one or two of its calyceal components before it can be lifted out of the pelvis. Usually the remaining parts can then be extracted by pulling them out, but when the infundibular passages are too tight, they can be pushed out against the renal cortex with a finger inserted in the pelvis, and lifted out through a small incision made into the capsule, which is widened and deepened with a hemostat. Accurate closure with fine, atraumatic sutures suffices to control bleeding and urinary leakage. When it is anticipated that a roentgenogram may be advisable to determine whether or not all of the fragments of the stone have been removed, a Bucky cassette can be placed under the patient, and because of the practically supine position, good films can be obtained without difficulty.

For surgery on the renal artery, the anterior transperitoneal approach is best, and is made especially easy by the use of a self-retaining retractor of the Smith type.

In patients who have a proven diagnosis of pheochromocytoma without roentgenographic evidence of a tumor large enough to cause renal displacement, laparotomy via a midline incision is the best approach because of the possibility of multiplicity or of an unusual retroperitoneal location of such tumors. The right adrenal gland can be brought into view by pulling downward on the kidney and incising the retroperitoneum under the retracted liver. After direct dissection of the adrenal, the large but very short central adrenal vein is clamped by inserting a long curved clamp between the vena cava and medial edge of the gland. On the left side, the central vein is easier to locate, as it connects with the superior, middle part of the renal vein.

Likewise, in women with endocrine problems of either adrenocortical or ovarian origin, in whom the endocrinologist is unable to make an accurate differential diagnosis, the midline incision permits careful exploration of both the adrenals and the ovaries. Some patients may have sclerocystic or other ovarian disease, some may have adrenal disease, and occasionally a woman may have both sclerocystic ovaries and an adrenocortical adenoma or hyperplasia.

Advantages to the anesthesiologist are that no change in the patient's position is necessary after induction of anesthesia, unrestricted respiration, and easier management of the patient in the supine position.

DISADVANTAGES

There are a few drawbacks to the anterior approach, which should be mentioned. In some extremely obese patients the kidney is buried deeply in renal fossa fat, so that an unusually long incision is needed for proper exposure; however, this would probably be the case anyway with the classic flank approach in such patients.

Damage to the splenic capsule can occur inadvertently from pressure of a retractor, and indeed, this has happened in a few instances. In all but one instance the tear in the splenic capsule was repaired by using compression and careful suturing with fine atraumatic sutures, or by the application of hemostatic material held in place by suturing adjacent fat to the capsule. The one splenectomy occurred in a patient who underwent endartectomy of the right renal artery through a right subcostal incision; the splenic tear resulted from retraction in the process of securing a needle biopsy of the left kidney. No difficulty has been encountered with the pancreas, duodenum, or liver, probably because these structures are well visualized and injuries minimized by careful protective packing and retraction.

CONCLUSIONS

In the past few years the anterior transperitoneal approach has been used for all surgery on the upper urinary tract (about 250 procedures) except open renal biopsy, emergency nephrostomy, and uncomplicated ureterolithotomy. This approach is the only satisfactory one for surgery on the renal artery. Since the crucial step of most renal surgery is performed on the medial aspect

of the kidney, the anterior approach offers the following advantages: the most direct route to the renal hilus, good exposure of the kidney, no need to mobilize the kidney unless nephrectomy or partial nephrectomy is undertaken, better control of bleeding, easier removal of stones from the renal pelvis or calyces, less immediate and late postoperative discomfort, fewer wound hernias, an opportunity to work on both kidneys simultaneously, and extension of the scope of the urologist in handling endocrine problems and laparotomy.

Peritonitis was not encountered, although many of the procedures were done in the presence of infected urine or kidneys. No urinary leakage into the abdominal cavity occurred, extraperitoneal drainage being used whenever the urinary tract was opened.

DISCUSSION

DR. J. HARTWELL HARRISON (Boston, Mass.): I should like to congratulate both Dr. Culp and Dr. Poutasse on their presentations. My remarks will be directed primarily to Dr. Culp's dissertation.

We have had an experience with the use of a modified Cherney procedure combined with extending the incision up to the costal margin to exose the kidney. Dr. Murray and I utilized this first in the transplantation of the kidney between twins when we wished to perform nephrectomy on the right side, having already removed the left kidney. This gives an exposure as beautifully illustrated by Dr. Culp, and it is quite effective.

It is a good procedure, when you have an opaque filling defect and you are not sure whether it is a stone or a tumor, to have the patient in the position Dr. Culp has shown and to go into the area and find out what you have. If it is a tumor we can proceed with a nephro-ureterectomy by the technique Dr. Culp has pointed out.

We have also had occasion to use this when the obstruction was not due to tumor in the ureter but due to an extraureteral tumor such as recticulum cell sarcoma of the retroperitoneum, and in one unusual case, a papillary tumor of the renal pelvis we had not demonstrated roentgenographically, there was metastasis into the periureteral lymphatics at a level below the iliac vessels. This I had not seen before.

We have only used this approach twice for tuberculosis of the kidney. We still have to do a nephrectomy occasionally for renal tuberculosis in Boston and a nephro-ueterectomy is nicely done by this approach. It is also effective for a subdiaphragmatic orchiectomy.

In one instance, we had retroperitoneal fibrosis where an ileal substitution was made from the renal pelvis to the bladder. I have a few illustrations all on the right kidney, Dr. Culp. Would it be all right, since yours were on the left, kidney, to look at a couple of them?

(Slide) This is the beginning of the exposure using the incision. We did not go across the rectus muscle in this case but went from the right lower quadrant up to the costal margin. Here is the ureter going behind the cava, and here is the dilated pelvis.

(Slide) This is enlarged a little further to give more of the type of exposure Dr. Culp has shown us. Then, of course, you are in a good position to divide the cava as recommended by Drs. Willard Goodwin and Harry Mueller, but not being primarily a vascular surgeon, I prefer to divide the pelvis here and to resect a portion of the redundant pelvis and reanastomose end to end.

(Slide) This is the result afterwards. Here is the cava, here is the ureter now lying in a straight line, anastomosed to the renal pelvis.

(Slide) Here is an instance of a nonopaque filling defect that might or might not be ureteral tumor. We have not attempted to get a biopsy of this cystoscopically. This is demonstrated by this exposure to be a tumor just below the iliac vessels.

(Slide) Here the ureter has been divided at the level of the bladder, and the tumor is in this area. The nephrectomy is proceeded with.

(Slide) This shows the specimen, with not enough of the bladder removed, Dr. Culp. I would not want to remove a large renal tumor or a large kidney by this incision, but one that isn't large is quite easily accomplished.

(Slide) Here is the instance of ureteral obstruction by metastases from the renal pelvis that have extended around the ureter below the iliac vessels.

(Slide) This is shown better here. Here we are lifting the ureter. Here is the vena cava, here is the ureter surrounded by tumor, and the ureter superiorly.

(Slide) I am very impressed with Dr. Poutasse's presentation. I have discussed this with him previously. It certainly is a definite advantage with reference to bilateral vascular approach, but I would question the justification for removal of stones from the renal pelvis by a transperitoneal approach. It certainly is ideal for pheochromocytoma, whether one makes a transverse abdominal incision or whether one makes a midline longitudinal incision.

However, for Cushing's syndrome I am certain from a few years' experience that this is not the

best approach when we have bilateral adrenocortical hyperplasia. This is better tolerated by the patient with a translumbar approach on the right through the eleventh rib and through the twelfth rib on the left side. Dr. Cahill utilized the transperitoneal approach for all of his adrenocortical tumors, but not for adrenocortical hyperplasia.

Dr. John K. Lattimer (New York, N. Y.): I was glad to hear that someone is keeping up an interest in nephrectomy for tuberculosis. In the rare cases where nephrectomy is still done, we don't think a lower ureterectomy is indicated at all.

(Slide) We think to marsupialize the ureter saves one the lower portion of the operation by bringing the lower ureter out to the lower end of the skin incision; letting it drain there with a tube in it and suturing it to the skin. The tube can be taken out after 5 days. The ureteral stump will then retract and heal over flush with the skin.

If there was a stricture here of the lower ureter, and if, by some remote chance, a tuberculous abscess did develop, the abscess would be immediately under the skin and would be no problem. Actually, we haven't had any problems when we have done this procedure.

(Slide) You can intubate the ureteral stump, and through the tube you can irrigate the ureter and bladder with anti-tuberculosis medications.

(Slide) We have made a comparison of complications after partial ureterectomy, where the ureter was cut in the middle. We have seen abscesses at the upper end of the stump of the ureter. When we exteriorized the ureters we had very few complications. With nephro-ureterectomy we also found very few complications. The advantage of the exteriorized stump method was that it saved the patient the ureterectomy portion of the operation.

Dr. Willard Goodwin (Los Angeles, Cal.): I should like to ask the essayists some questions.

I should like to ask Dr. Culp for a little more description of how he gets the ureter and the cuff of the bladder. Does he open the bladder from the front and take it out from inside, or does he pull it up and cut it off with the cuff attached? Also, how does he close the bladder under these circumstances?

I should like to ask Dr. Poutasse if he has ever approached the left renal artery from the flank instead of from the front. The same for the right side. Also, how does he feel about mobilizing the vena cava medially instead of laterally?

Dr. Grayson Carroll (St. Louis, Mo.): Concerning surgical incisions, I would like to report an unusual one seen in our visit to Russia. Doctors Colston, Bobbitt, and I were invited to the urological surgical clinic in Moscow conducted by the dynamic Dr. Pytel. In exposing a kidney which he suspected of having a ureteral tumor, he used a V shaped incision, the apex of which was at the costovertebral angle. The lower limb of this incision extended as the usual kidney incision—the costovertebral angle obliquely downward to one inch above the iliac spine. The upper limb of the V extended from the costovertebral angle across the twelfth rib to the midline. This incision went boldly through the skin, the fascia, and the muscles, but miraculously escaped the peritoneum. This pie-shaped mass was swung medially and the peritoneum drawn medially, exposing quite well the kidney and the upper ureter.

We were not as enthusiastically impressed with this incision as Dr. Pytel seemed to be since we believe that these incisions, as suggested today, are superior to it.

Dr. Ormond S. Culp (Rochester, Minn.): Dr. Goodwin, most of these patients had cystoscopic examinations. When the remainder of the bladder appeared normal, we did not open the bladder anteriorly and expose the ureteral orifice, but merely dissected the ureter from above, including the intramural portion, and excised the orifice. The bladder usually was closed with two layers of catgut and an indwelling catheter was inserted.

As everybody here knows, there are many types of incisions for renal operations and I am sure there never will be complete agreement regarding which are best. I doubt if anyone should do all types of renal surgery through one particular type of incision. The anterior one which we described has special advantages only in properly selected cases.

Dr. Eugene F. Poutasse (Cleveland, Ohio): In regard to Dr. Goodwin's question as to whether I have approached the left renal artery through

the classic left flank incision, the answer is no. It would be quite difficult because you would have to mobilize the kidney to get down to the artery and vein, and this would disturb valuable collateral circulation.

If trouble develops from a sudden hemorrhage, there might be considerable difficulty in applying arterial clamps to the aorta. It is better to come through the midline, where, if unexpected hemorrhage does occur, one is in a better position to maneuver and control bleeding.

The second question related to mobilization of the vena cava medially instead of laterally for right renal artery surgery. It depends on where the lesion is in the renal artery. If the lesion is in the distal portion of the renal artery, then the vena cava is mobilized and retracted medially. The lesion demonstrated was at the very orifice of the right renal artery, and hence the vena cava was retracted laterally.

In regard to hyperplasia causing Cushing's syndrome, I found it quite easy, Dr. Harrison, to remove either totally or subtotally both adrenals through the anterior transperitoneal approach. Dr. George Crile, Jr. was interested in this, and as he watched me doing a total adrenalectomy on the right side one day, he shuddered and left the room. Evidently, he didn't feel that he would like to resect the right adrenal gland in this manner.

DIFFERENTIATION OF HYPERPARATHYROIDISM AND OTHER DISEASES ASSOCIATED WITH RECURRENT URINARY CALCULI: A CLINICAL EVALUATION OF SOME CURRENTLY AVAILABLE LABORATORY METHODS

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An estimated 80 to 85 per cent of all patients with urinary calculi have only one or two episodes of calculus formation in their entire lives. These calculi are usually small calcium oxalate and/or calcium phosphate stones which are passed through the ureters and which are unassociated with recognized systemic or urinary tract disease. The remaining 15 to 20 per cent of patients have bilateral or rapidly recurrent urinary calculi. Unless the stone formation can be controlled, these patients face repeated hospitalization, multiple surgical procedures, and eventual death from renal insufficiency or hypertension. These individuals have a relatively high incidence of endocrinologic, metabolic, malignant, or degenerative diseases which appear to be a primary factor in the severity of their calculus formation.[1] The majority of these diseases are characterized by their protean symptoms and by their chronicity, with unpredictable periods of remission and exacerbation. It is important to establish the diagnosis early in the course of the disease, not only to prevent stone formation, but to arrest the insidious alterations in body structure and function which may be irreparable by the time the diagnosis has become obvious.

The subjects for this study were 90 consecutive patients with bilateral or rapidly recurrent renal calculi and in whom there was no obvious disease which would predispose to stone formation. Patients with obvious or established diagnoses were excluded from the study. Such exclusions included patients with known malignant disease, with or without osseous metastases, patients with a history of poliomyelitis or prolonged immobilization, patients with congenital anomalies or foreign bodies within the urinary tract, and patients with obvious symptoms and signs of hyperparathyroidism (9 patients, 2 of whom were in parathyroid crisis). There were 58 males and 32 females ranging in age from 6 to 77 years.

Supported by a grant from the John A. Hartford Foundation.

[1] Boyce, W. H., Norfleet, C. M. and Garvey, F. K.: Therapeutic approach to the problem patient with urinary calculi. South. Med. J., **52**: 443–450, 1959.

METHODS

The patients were admitted to the Renal Diagnostic Unit of the Metabolic Section. Admissions were at an elected time when there had been no recent episode of renal colic, severe infection, or recent surgical procedure. Immediately after admission, baseline biochemical determinations were made of total serum proteins with albumin and globulin ratio, blood urea nitrogen, and serum concentrations of calcium, phosphorus, alkaline phosphatase, CO_2 combining power, and chloride. All medications were discontinued, and clean-catch urine specimens obtained for pour-plate cultures.

Tests of renal function were limited to osmolar concentration following water deprivation with determination of pH of each specimen. Excretory urograms and other tests of renal function were not done until after the diagnostic procedures, since transient proteinuria and presumably other disturbances of renal function may accompany the latter procedure. Roentgenograms of the skull, teeth, chest, hands, and abdomen were obtained. The patients were placed on three days of controlled diet containing 160 mg. calcium and 1.05 gm. phosphorus per 24 hours. During this period, daily 24-hour urinary collections were made for determination of calcium and phosphorus excretion, and, in most instances, determinations of the titratable acidity. The tubular reabsorption of phosphate was determined on the third day, utilizing a 24-hour excretion of phosphorus and creatinine and a fasting serum phosphorus and creatinine drawn at the be-

TABLE 1. *Influence of intravenous calcium on urinary calcium and phosphorus excretion*

		Urine Ca mg./24 hrs.			Urine P mg./24 hrs.		
		Pre load	Load	Post load	Pre load	Load	Post load
Controls	mean	104	372	120	654	413	695
	S.D.	75.1	95.3	52.4	214.0	208.9	342.0
	range	30–249	263–536	70–193	400–945	202–679	357–1145
Parathyroid adenomas	mean	253	402	188	591	515	489
	S.D.	130.9	131.9	111.1	173.3	161.4	120.4
	range	62–390	137–518	48–308	391–834	250–735	309–640
Parathyroid hyperplasias	mean	233	630	251	709	561	345
	S.D.						
	range	123–343	630	173–330	428–990	561	345
Chronic pyelonephritis	mean	140	445	150	636	527	602
	S.D.	76.8	190.9	72.2	278.7	214.3	253.6
	range	21–313	175–837	30–350	226–1438	130–1076	71–1152
Idiopathic hypercalcinuria	mean	143	576	199	703	541	740
	S.D.	61.9	136.4	74.4	545.5	263.3	217.3
	range	75–265	383–866	110–362	269–2256	143–1045	324–920
Normal parathyroids at operation	mean	187	487	191	773	556	642
	S.D.	100.2	199.3	89.3	270.9	228.2	246.6
	range	83–327	175–837	36–332	373–1438	143–1076	141–884
Other metabolic disorders	mean	159	434	86	597	398	465
	S.D.	101.6	145.4	39.6	151.5	207.9	220.3
	range	83–382	298–652	36–130	403–780	110–630	141–732

ginning of the collection period.[2, 3] The creatinine determinations were by the method of Taussky.[4]

On the morning of the fourth day, the intravenous calcium load tests were performed as described by Howard, Hopkins, and Connor.[5, 6] The patient was fasting during the day of this test, receiving a complete meal at 8 p.m. after the 12-hour blood samples were drawn. Water was admitted *ad libitum* during the test; a minimum intake of 1200 cc was required. After obtaining baseline serum calcium and phosphorus concentrations (0 hours in the accompanying graphs), an infusion of calcium gluconate-glucoheptonate in 500 ml. normal saline was begun and regulated by constant attention to permit the infusion of 15 mg. of calcium per kilogram of body weight over a period of 4 hours (0–4 hrs. on the accompanying graphs). Blood samples for calcium and phosphorus determinations were drawn at 4, 8, 12, and 24 hours after beginning the infusion. Twenty-four hour urine collections were made from 8 a.m. to 8 a.m. on

[2] Chambers, E. L., Jr., Gordon, G. S., Goldman, L. and Reifenstein, E. C., Jr.: Tests for hyperparathyroidism: tubular reabsorption of phosphate, phosphate deprivation, and calcium infusion. J. Clin. Endocrinol., **16:** 1507–1521, 1956.

[3] Reiss, E. and Alexander, F.: The tubular reabsorption of phosphate in the differential diagnosis of metabolic bone disease. J. Clin. Endocrinol., **19:** 1212–1222, 1959.

[4] Taussky, H. H.: A procedure increasing the specificity of the Jaffe reaction for the determination of creatine and creatinine in urine and plasma. Clin. Chim. Acta, **1:** 210–224, 1956.

[5] Howard, J. E., Hopkins, T. R. and Connor, T. B.: Use of intravenous calcium as a measure of activity of the parathyroid gland. Trans. Ass. Amer. Phys., **65:** 351–358, 1952.

[6] Howard, J. E., Hopkins, T. R. and Connor, T. B.: On certain physiologic responses to intravenous injection of calcium salts into normal, hyperparathyroid and hypoparathyroid persons. J. Clin. Endocrinol., **13:** 1–19, 1953.

the day of the test and on the day following the test.

The relative changes in serum calcium and phosphorus were charted as shown in the accompanying graphs. The graphs were constructed so that the upper limit of normal serum calcium (11 mg./100 ml.) coincided with the lower normal limit of serum phosphorus (2.5 mg./100 ml.). Thus, in the normal individual, at 0 hours, the serum phosphorus would always appear at some point above the serum calcium determination at 0 hours. This straight-line relationship is arbitrary, but quite useful in demonstrating relative variations in serum calcium and phosphorus concentration. The data have been charted in a number of variations which have included logarithmic relations and Ca × P products in the serum. From a clinical point of view, these more technical graphs have not improved the interpretive evaluation of the data.

The change in urinary phosphorus was calculated from the 24-hour excretion on the day of the load, as compared with the first day following the load, and expressed as per cent increase or decrease from that determined on the day following the load.

In the following discussion, all determinations of urinary excretion "pre-load" refer to the 24 hours prior to the intravenous calcium test, and those referring to "post-load" refer to the 24-hour period beginning 24 hours after initiation of the infusion.

The above methods completed the data to be presented in the present report. More definitive

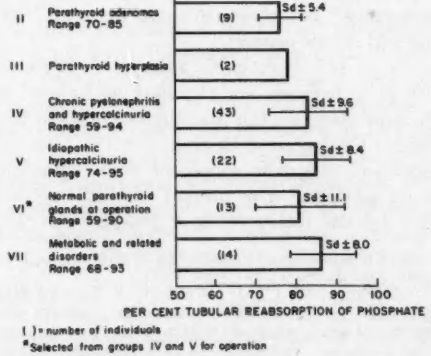

FIG. 1

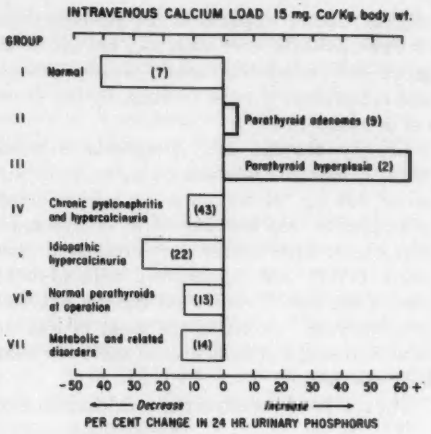
INTRAVENOUS CALCIUM LOAD 15 mg. Ca/Kg. body wt.
GROUP
I Normal (7)
II Parathyroid adenomas (9)
III Parathyroid hyperplasia (2)
IV Chronic pyelonephritis and hypercalciuria (43)
V Idiopathic hypercalciuria (22)
VI* Normal parathyroids at operation (13)
VII Metabolic and related disorders (14)
-50 40 30 20 10 0 10 20 30 40 50 60+
Decrease
Increase
PER CENT CHANGE IN 24 HR. URINARY PHOSPHORUS
( ) = Number of individuals
*Selected from groups IV and V

FIG. 2

diagnostic procedures, such as excretory urography, ability to acidify the urine following an acid load, biopsy of lymph nodes, skin, or bone, Ellsworth-Howard parathormone test, and other diagnostic procedures, were deferred until the above examinations had been completed.

RESULTS

Group I. Normal control subjects (4 male, 3 female). These volunteer individuals had no history or evidence of urinary tract disease or other recent acute or chronic illness. The urinary calcium and phosphorus excretions are recorded in table 1. Per cent tubular reabsorption of phosphate is recorded in figure 1. The alteration of renal phosphate excretion following the intravenous calcium load is illustrated in figure 2.

The results of the intravenous calcium load are shown in figure 3. The fasting "pre-load" serum calcium concentration was 9.9 mg./100 ml. and the phosphorus 3.4 mg./100 ml. Note that by the method employed in the construction of this graph, concentration of serum phosphorus is consistently plotted well above the concentration of serum calcium, and this prevails throughout the test day (fig. 3).

Group II. Parathyroid adenomas (4 male, 5 female). Nine patients were found to have a solitary adenoma of the parathyroid gland by the classical gross and histologic criteria for the disease.[7] The diagnoses were confirmed by the sub-

[7] Castleman, B. and Mallory, T. B.: The pathol-

sequent clinical response of the patients. None of these patients were azotemic, but six of the group had intractable chronic urinary infection and impairment of renal function by the phenol red excretion test.

Urinary calcium and phosphorus excretion (table 1) indicates that urinary calcium excretion above 250 mg./24 hrs. on a low calcium intake is suggestive, but not diagnostic, of hyperparathyroidism. The tubular reabsorption of phosphate (TRP) was significantly reduced below that of the normal individual (fig. 1), but there is considerable overlap in the range of this test in various stages of renal disease and other metabolic disorders.

The results of the intravenous calcium load are

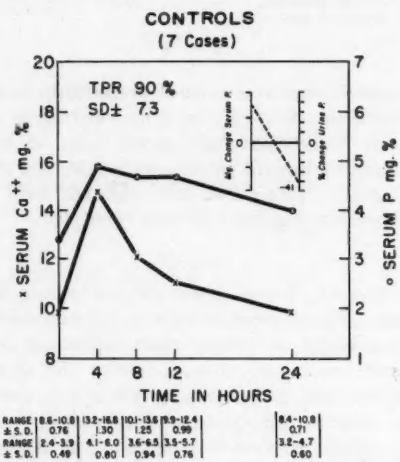

FIG. 3. Average values for serum calcium (× - - - ×) and phosphorus (○ - - - ○) during intravenous calcium test in 7 normal subjects. Values at 0 hours were obtained immediately prior to beginning an infusion of 15 mg. calcium per kg. body weight which was completed at 4 hours. Range and standard deviation for each determination are listed in table immediately beneath the designated hour. The mean TRP and standard deviation for group are listed in upper left corner of chart. Insert in upper right corner is a plot of maximal change in serum phosphorus and per cent change in urinary phosphorus during time of test. Serum phosphorus is expressed as absolute change in mg/100 ml. of serum phosphorus. Urinary phosphorus is expressed as per cent variation from 24-hour phosphate excretion during 24 hours following test. Increase is plotted above zero base line, decrease below it. Two points thus determined are connected by dotted line which is maintained as reference in figures 4–9. These symbols and methods of organization of data are duplicated in figures 4–9 inclusive.

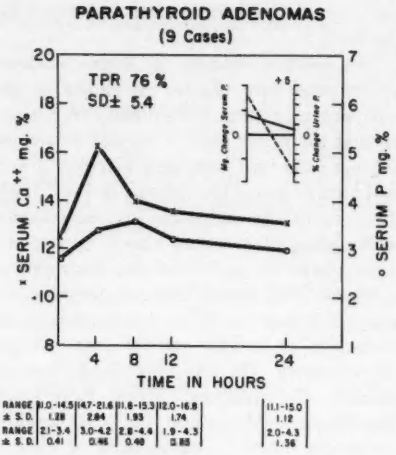

FIG. 4

presented in fig. 4. The fasting serum calcium ranged from the upper limit of normal to 14.5 mg. per cent, with a mean value of 12.5 mg. per cent. As previously reported by others[6, 8] the maximal elevation in serum phosphorus (mean value 0.8 mg./100 ml.) was significantly less than in the normal subjects (mean value 1.5 mg./100 ml.). The relative concentrations of serum calcium and phosphorus are reversed from those of the normal (fig. 3) and indeed from those of all other patients in this series, with the exception of the patients with primary hyperplasia of the parathyroid glands (fig. 5). Note that in the patients with primary hyperparathyroidism, the serum calcium concentration is consistently plotted on this graph above the serum phosphorus concentration at all stages of the test. Similar results were obtained by Howard and associates,[6] but they are more apparent when plotted in this manner.

Group III. Parathyroid hyperplasia (2 males). These 2 patients are classified as hyperplasia because two of the parathyroid glands were larger than normal in size, and the histologic structure was more consistent with hyperplasia than adenoma. The urinary calcium excretion and tubular reabsorption of phosphate in these

ogy of the parathyroid gland in hyperparathyroidism. Am. J. Path., **11:** 1–72, 1935.

[8] Thomas, W. C., Jr., Connor, T. B. and Morgan, H. G.: Some observations on patients with hypercalcemia exemplifying problems in differential diagnosis, especially in hyperparathyroidism. J. Lab. Clin. Med., **52:** 11–19, 1958.

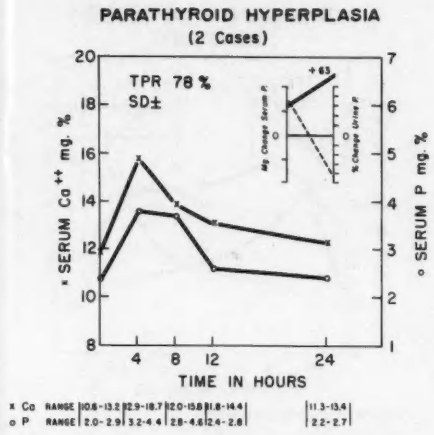

FIG. 5

patients are within the range of those with parathyroid adenomas. The response to the intravenous calcium load test, in the relative concentrations of both serum calcium and serum phosphorus (fig. 5), and a 63 per cent increase in urinary phosphorus excretion during the load (fig. 2) are consistent with primary hyperparathyroidism.

Group IV. Chronic pyelonephritis (43 patients). All of these patients had a long history suggestive of urinary tract infection and repeated calculus formation. None of the group was azotemic. Twenty-six had bilateral calculi at the time of this study, and the remainder had large "staghorn" or multiple unilateral calculi. Known febrile episodes and previous positive urine cultures had been obtained in all patients. Bacteria recovered at the time of the study are listed in table 2.

With the exception of one patient who had a congenital fused (horseshoe) kidney, there was no evidence of obstructive disease; and no demonstrable cause of their stone formation, other than infection, could be elicited by history or laboratory examinations. Under the conditions of these experiments, the normal individuals had a mean urinary calcium excretion of 104 mg./24 hrs. and a maximum of 249 (table 1). Of the 43 pyelonephritic patients, 16 had urinary calcium excretion rates below 104 mg./24 hrs., 20 had urinary calcium excretion rates between 104 and 249 mg./24 hrs., and only six had calcium excretion rates above 249 mg./24 hrs. The mean calcium excretion for the group is therefore somewhat above the normal. However, there is not enough difference to warrant the assumption that these are, in general, hypercalcinuric patients who have acquired urinary infections. Neither was there any clear correlation between the type of infecting organism and the hypercalcinuria.

It is impossible to determine whether the infection preceded the calculus formation in this group of patients. The typical patient has a long history of urinary symptoms, usually beginning in childhood or early adulthood. The symptoms frequently antedate the diagnosis of calculus by several years. The initial calculi were usually small and had passed spontaneously. Later ureteral manipulations of calculi or diagnostic urinary instrumentation had occurred repeatedly. The history suggests coincident progressive calculus formation and infection proceeding hand-in-hand. The role of infection in the current status of stone formation in this group of patients is suggested by the clinical response of those individuals in whom all calculi have been removed at one time from the urinary tract, and in whom vigorous and prolonged antimicrobial therapy has been clinically effective. The rate of recurrent stone in this group is significantly less than the rate of stone growth in those individuals from whom all stones could not be removed (technical error or patients with nephrocalcinosis) or in

TABLE 2. *Bacteria recovered by culture of the urine from 43 patients with chronic pyelonephritis, group IV*

	No.	%	
Proteus (sp.)	10	23	
Aerobacter aerogenes	5	12	33%
Coliform organisms	5	12	
Mixed Aerobacter and coliform	4	9	
Pseudomonas	4	9	
Hemolytic staphylococci	4	9	
Alpha or beta hemolytic enterococci	2	5	
Paracolon	1	2	
Unidentified*	8	19	
	43	100	

* Bacteria demonstrated, but cultures revealed diphtheroids, coagulase negative staphylococci, or less than 100,000 organisms per ml.

whom the urinary tract infection could not be controlled (Proteus or Pseudomonas infection).

The effect of impaired renal function on serum concentrations of calcium and phosphorus is well established, and the difficulties of evaluating the functional status of the parathyroid glands are increased in the presence of renal disease. Since approximately one half of problem stone formers are in this category of chronic urinary infection, this is the group in whom a differential diagnosis of hyperparathyroidism is most important and usually most difficult. Note that the tubular reabsorption of phosphate is reduced to such an extent in these patients (groups IV and VI, fig. 1) as seriously to impair its diagnostic significance. The renal excretion of phosphate following the intravenous calcium load is also more like the group III parathyroid adenomas than the normal subjects (fig. 2). However, the maximal increase in serum phosphorus (mean value 1.5 mg./100 ml.) during the calcium load is distinctly greater than the patients with hyperparathyroidism (mean value 0.8 mg./100 ml.). The serum calcium-phosphorus relations as plotted on the standard graph (fig. 6) are clearly not reversed from the normal (fig. 3) and are distinctly different from the hyperparathyroid patients (fig. 4).

Group V. Idiopathic hypercalcinuria (22 patients). Fifteen of these patients had had calculi in both kidneys, and seven had had multiple stone formation in one kidney. No demonstrable anatomic abnormality of the urinary tract was present at the time of study. No patient in this group had any history or physical sign suggestive of bacterial infection in the urinary tract. No significant numbers of bacteria were demonstrable in the urinary sediment or in the urinary cultures. Large calculi were observed in this group, but no magnesium ammonium phosphate calculi were found. It was of interest that 2 patients in this group were identical twins, a history of stone formation in siblings was obtained from two other members of the group, and a history of stone formation in the family was obtained from seven others.

All of these individuals had been demonstrated to have urinary calcium excretion rates greater than 250 mg./24 hrs. as outpatients on unselected diets. Under the conditions of these experiments, 17 per cent reduced their calcium excretion rates

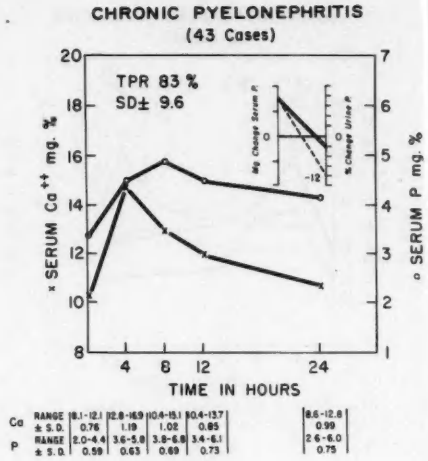

FIG. 6

to less than 104 mg./24 hrs., 28 per cent to between 104 and 249 mg./24 hrs., and 25 per cent remained above 249 mg./24 hrs. The urine of these patients was characterized by low pH, often in the range of 5 on chance specimens, and always approaching 5 during the water deprivation test. There were no uric acid calculi in these individuals, although blood uric acid concentrations were slightly above the normal range in more than half of the subjects. It is of interest that after three days of low calcium intake these patients have serum calcium concentrations well within the normal range (mean value of 10.3 mg./100 cc). The fasting Ca × P ratio for this group was 31.9, as compared with 33.7 for the normal and 35 for groups III, IV, and VII.

These group V patients tended to have a higher than normal urinary phosphorus excretion rate, and the maximal phosphate excretion in some individuals of this group exceeded any other patients in the study (table 1). An effort was made to establish a correlation between the rate of phosphorus excretion and the urinary response in terms of calcium excretion following instigation of a low calcium diet. No clear correlation could be established.

The tubular reabsorption of phosphate (fig. 1) and the failure of the intravenous calcium load test to elicit a renal suppression of phosphorus excretion equal to that of the normal (fig. 2) suggest an abnormality of tubular transport of

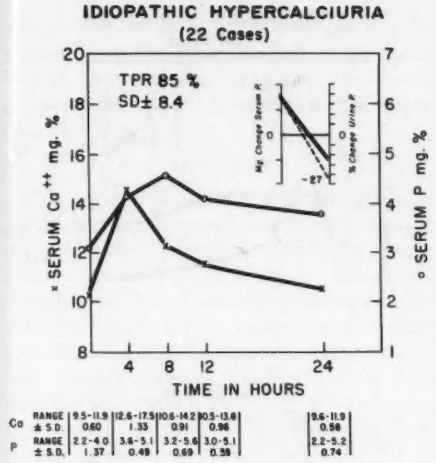

FIG. 7

phosphorus. Whether this is a primary defect remains to be determined.[9] Renal function by phenol red excretion was not impaired in these patients. The implications, however, of some abnormality in the anion-cation balance of these patients is inescapable. They appear to have a tendency to systemic acidosis, which is compensated at the renal level by persistent excretion of a highly acid urine.

The response of relative serum calcium and phosphorus concentrations during the load test is similar to the normal individual and distinctly different from those with primary hyperparathyroidism (fig. 7).

Group VI. Normal parathyroid glands demonstrated by surgical exploration (13 patients). The difficulty of establishing the diagnosis of primary hyperparathyroidism in the presence of renal disease is well known. Furthermore, the evaluation of a diagnostic procedure requires knowledge of false negative as well as false positive results. Eleven patients from group IV with bilateral calculi and advanced pyelonephritis and two patients from group V with multiple recurrent bilateral calculi were selected for exploration of the parathyroid glands. These patients were selected on the basis of diagnostic procedures which were, by some of the criteria, suggestive of primary hyperparathyroidism. Nine of the group had hypercalcinuria of 205 to 327 mg./24 hrs. in spite of the restricted calcium intake. Four of the group had normal values for urinary calcium excretion, but serum calcium of 11.9 to 12.2. The mean serum calcium for the group was 10.8 mg. per cent, and the mean serum phosphorus 3.4 mg./100 ml.

The tubular reabsorption of phosphate (fig. 1) was reduced from the normal, and urinary phosphorus was not greatly suppressed by the calcium load (13 per cent as compared with the normal of 41 per cent, fig. 2).

The response of the serum phosphorus to the intravenous calcium load test, however, was within the normal range, and the relative calcium and phosphorus concentrations (fig. 8) were quite similar to the normal controls (fig. 3) and quite different from the patients with primary hyperparathyroidism (fig. 4).

Normal parathyroid glands were demonstrated at operation. This was confirmed by biopsy or surgical removal of those glands which appeared slightly enlarged. Two patients who had severe calculus disease and in whom four parathyroid glands were not found in the cervical exploration were subjected to mediastinal exploration. No parathyroid tissue was found in the mediastinum in either instance.

This group of patients suggests that the most

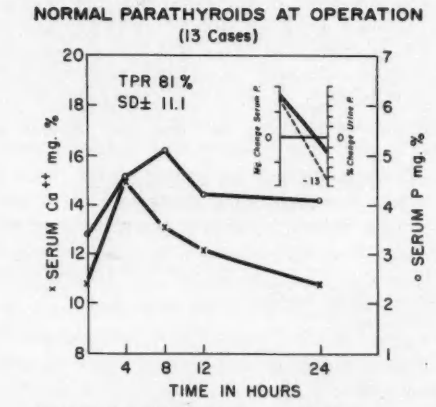

FIG. 8

[9] McGeown, M. G.: Normal standards of renal phosphate clearance and observations on calculus patients. Clin. Sci., **16**: 297–307, 1957.

reliable indication of hyperparathyroidism is obtained from the relative concentrations of serum calcium and phosphorus throughout the intravenous calcium load as plotted in figures 3 and 4.

Group VII. Various other metabolic and degenerative disorders (14 patients). Excluded from this study were patients in whom the diagnosis had previously been established, or in whom history, physical examination, or survey biochemical determinations were strongly suggestive of metabolic disease. The final diagnoses are listed in table 3. The mean values of urinary calcium excretion and tubular reabsorption of phosphate are presented in table 1 and figures 1 and 2. The relative concentrations of serum phosphorus and calcium during the intravenous calcium load are illustrated in figure 9. Note that the mean increase in serum phosphorus (1.0 mg./100 ml.) is not greatly different from that of the parathyroid adenoma patients (mean value 0.8 mg./100 ml.). When the relative serum calcium and phosphorus concentrations are plotted on the standard graph (fig. 9), there is no reversal from the normal as is true of the group II parathyroid patients.

The individual response to the intravenous calcium load test was far more interesting than this composite graph would indicate. The patients with sarcoidosis demonstrated elevations of serum calcium to a maximum of 28 mg./100 ml. at the termination of the infusion, and a significant persistence of the elevated serum calcium to as much as 15 mg./100 ml. at 12 hrs. and to 13.8 mg./100 ml. at 24 hrs. This is in accord with previously reported observations that patients with sarcoidosis have an increased intestinal absorption of calcium, and one may assume a

TABLE 3. *Patients with metabolic or degenerative disorders*

	No.
Renal tubular acidosis	3
Osteoporosis	
Senile	2
Post-menopausal	2
Sarcoidosis	2
Renal rickets	2
Milk alkali (Burnett's) syndrome	2
Oxalosis syndrome	1
	14

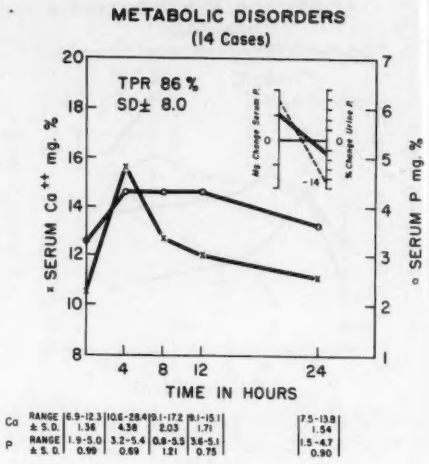

FIG. 9

surfeit of calcium in their body pool. Under these conditions, one would anticipate their bone and other available sites for temporary calcium storage to be saturated, and hence the abnormal elevation in serum calcium concentration. The ultrafiltrability of serum calcium and phosphorus was probably altered by the test and may have been abnormal prior to the test.[6]

In contrast, the 2 patients with renal rickets, having a low serum calcium concentration, reached only a normal concentration by the end of the infusion and had returned to subnormal levels within four hours after discontinuing the infusion. The 3 patients with congenital renal tubular disease and inability to acidify the urine responded in a similar but less dramatic fashion. These individuals are considered to have a deficit of body calcium, which may be expressed as "bone hunger." An essentially normal response of serum calcium and phosphorus was observed in the patients with osteoporosis.

The patients with renal rickets demonstrated *no* significant increase in serum phosphorus during the infusion and, indeed, reduced the serum phosphorus slightly, following discontinuation of the infusion. A similar response has been observed in a 12-year-old girl with primary bone tumor and serum alkaline phosphatase of 29 Bodansky units.

The patients with sarcoidosis had maximal increase in urinary phosphorus by 1.8 mg. above the pre-load determinations, with an essentially

normal response at 24 hours after the test. The patients with osteoporosis and renal tubular acidosis demonstrated essentially normal response of the serum phosphorus to the intravenous load test.

DISCUSSION

The majority of patients with primary hyperparathyroidism have per cent tubular reabsorption of filtered phosphate (TRP) significantly below the normal range. However, patients with severe renal stone formation, including those with malignant tumors and various metabolic and endocrinologic disorders, as well as renal disease without azotemia, commonly have reductions of TRP within the range encountered in hyperparathyroidism. Furthermore, an occasional patient with parathyroid adenoma will have a normal TRP even with high levels of phosphate intake.[3] The clinical usefulness of this test seems limited to the differentiation of hyperparathyroidism from normal subjects—a problem infrequently encountered in urology.

The intravenous calcium load as originally described by Howard, Hopkins, and Connor[6] is clinically the most reliable measure of the activity of the parathyroid glands. The test should be performed as described by these investigators under the carefully controlled conditions of a metabolic ward. The diagnostic implications of the test are interpreted with greater facility when all of the data are plotted on some standard form (fig. 3), rather than relying on a single value such as the maximal increase in serum phosphorus or per cent change in urinary phosphorus excretion. The low calcium-normal phosphorus intake for 3 days may have conditioned the parathyroid glands to optimal activity on the day of the test since serum calcium levels tended to be slightly higher than on the day of admission.

Many factors influence the equilibrium existing between bone mineral and serum calcium concentrations. Excellent reviews of this subject have been presented by McLean[10] Neuman and Neuman,[11] Howard,[12] Bourne,[13] Epstein,[14] and others. In general, there is considered to be a rapidly acting equilibrium of serum calcium with the labile fraction of bone mineral, which is adequate to maintain the calcium level at approximately 7 mg./100 ml. The minute-to-minute interplay between blood and bone appears to lie in this area, and indeed in young animals the turnover of the blood calcium may amount to as much as 100 per cent per minute. The total serum calcium concentration is monitored by the parathyroid glands under control of a feedback mechanism which is responsible for a slower, hour-to-hour adjustment to maintain the total serum calcium at near the normal level of 10 mg./100 ml. A miscible pool of body calcium thus exists under the influence of many diverse forces. The size of this pool in terms of grams of calcium has been determined in only a few subjects, but has varied between 1.5 to 3.1 gm. in osteoporosis, 4.1 gm. in parathyroid adenoma, and 7.3 gm. in Paget's disease.[15] The rate of disappearance of infused calcium from the serum is a function of the expansibility of the pool as well as the rate of exchange with bone crystal. It is not surprising that short term studies frequently indicate an apparent independence of intestinal absorption, serum concentration, and renal excretion of calcium in many disease states.

The etiology of the hypercalcinuria commonly observed in patients with multiple renal calculus formation has not been satisfactorily explained. If this defect is primary in the renal tubular mechanism, then one must assume that intestinal absorption invariably provides an adequate compensatory mechanism and prevents a diminution in total body calcium. Otherwise, the intravenous calcium load would demonstrate "bone hunger" by a minimal increase in serum calcium during the intravenous infusion and a rapid return of the serum calcium to normal, after the manner of patients with renal tubular acidosis or renal rickets. One would also anticipate serum calcium levels near the lower limits of normal range, whereas, in fact, serum calcium levels are near the upper limits of normal for practically all patients with recurrent calculi. On the other hand,

[10] McLean, F. C.: The ultrastructure and function of bone. Science, **127:** 451–456, 1958.

[11] Neuman, W. G. and Neuman, M. W.: The Chemical Dynamics of Bone Mineral. Chicago: Univ. of Chicago Press, 1958.

[12] Howard, J. E. and Connor, T. B.: A discussion of calcium homeostasis: the role of the skeleton and some speculations on the part played by the parathyroid hormone. Bibl. Paediat., **58:** 230, 1954.

[13] Bourne, G. H., ed.: The Biochemistry and Physiology of Bone. New York: Academic Press, 1956.

[14] Epstein, F. P.: Calcium and the kidney. J. Chron. Dis., **11:** 255–277, 1960.

[15] Rich, C.: The distribution of calcium given to human subjects by sustained intravenous infusion. J. Clin. Endocrinol., **20:** 147–156, 1960.

if one postulates a primary defect in the transport mechanism of the intestinal epithelium with a resultant high rate of calcium absorption, one would anticipate saturation of the body pool of calcium with a marked increase in serum calcium concentration during the intravenous test after the manner of patients with sarcoidosis. The mean increase in serum calcium and subsequent return to normal of the serum calcium following the intravenous load test in idiopathic hypercalcinuric patients with recurrent calculi is indistinguishable from that of the normal individual. The rate of excretion of urinary calcium during or following the intravenous load is of little aid, either as a diagnostic criterion or in the elucidation of the etiology of the hypercalcinuria. Only the patients with renal rickets and renal tubular acidosis had less calcium excretion on the day following the load than during the pre-load determinations.

The hypercalcinuria and decreased renal tubular reabsorption of phosphorus found in many of these 90 patients with renal calculi are very similar to data derived from 25 peptic ulcer patients by Fromm and associates.[16] These investigators interpreted the hypercalcinuria in terms of increased renal clearance of calcium. An intravenous infusion of calcium (13 mg./kg. body wt.) produced an average per cent variation in urinary phosphorus excretion of −17.5 per cent, ranging between −70 and +70 per cent. The average percentage increase in urinary calcium excretion was 37.9 per cent following this infusion. Fromm and associates suggested that these data indicated an increased parathyroid function, possibly at some level between the upper limits of normal and the fully developed hyperplasia or adenoma. Intriguing as this concept may be, there are little data to support it as a significant etiologic factor, either in renal calculus disease or in peptic ulcer formation. Too many other plausible interpretations are equally as valid explanations for the same data.

[16] Fromm, G. A., Fideleff, E., Ferreño, M., Najenson, H. and Funes, J. C.: Parathyroid function in patients with peptic ulcer. Acta Endocrin., **32:** 448–462, 1959.

SUMMARY

Ninety patients with rapidly recurrent renal calculus disease have been studied on the renal diagnostic unit of a metabolic ward. Primary hyperparathyroidism was found in 12 per cent, various metabolic disorders in 16 per cent, chronic urinary infection in 48 per cent, and idiopathic hypercalcinuria in 24 per cent.

The intravenous calcium load test, as originally described by Howard, Hopkins, and Connor,[6] has been the most valuable diagnostic aid in the differentiation of early hyperparathyroidism from other types of calculus disease.

All of the data available from the patient response to the intravenous calcium should be utilized in interpretation of the diagnostic implications of the test. Until such time as reliable methods for direct measure of parathormone in body fluids become available, the diagnosis of hyperparathyroidism remains subject to the clinical acumen of the physician.

The authors wish to acknowledge the professional advice and assistance of Dr. John H. Felts, assistant professor of internal medicine; Dr. Samir Naguib, research fellow in urology; and Dr. Kenneth P. Carlson, resident in urology. Technical assistance was rendered by Mrs. Phyllis Tilley and Mrs. Betty Masten.

OPERATIVE TREATMENT OF MEGAURETER

PETER BISCHOFF

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Except for those infantile urinary obstructions caused by diseases and malformations of the central nervous system, we believe that the majority of urinary obstructions are mechanically stimulated.

We could not prove the existence of a causative so-called aganglionic zone of sympathetic innervation in the urinary tract. I shall discuss the particulars of these questions elsewhere.*

Today we hold to the opinion that surgical removal must be undertaken in all cases of mechanically stimulated or caused urinary obstructions.

Table 1 is a tabulation of 232 surgical procedures and 13 conservative methods which we applied to 96 children under 14 years of age. The results tabulated concern only local success. For instance, bilateral megaloureter with bilateral reflux is listed five times: once as a cured ostioplasty, once as a successful resection of the lower ureter, once as an unchanged ostioplasty, once as a deteriorated resection of the lower megaloureter and finally as a cured secondary Boariplasty.

Ostioplasty for removal of vesicoureteral reflux yields satisfactory results, as does resection of the lower ureter. On the other hand, the results obtained in bladder neck obstructions are remarkably unsatisfactory. Of 18 operations, only eight were successful; five were failures. Two late deaths occurred and 3 patients are still under treatment.

The results of secondary Boariplasty, which without exception has been applied after failures of plastic operations on megaloureter, are very satisfactory. The procedure has been used especially after uretero-neocystostomy which had been carried out elsewhere, and also after some of our own resections of the lower ureter that were followed by severe stricture formation or reflux or fistula.

The results of our own uretero-neo-cystostomies have been poor; the results of corrections of megaloureters in ureteroceles, reduplication of kidney and other malformations have been satisfactory.

Remarkably good results have followed conservative measures such as catheterization and dilatation with bougies, especially in infants with residual urine. Similar good results of much greater extent in infants recently have been reported by Lattimer.

In table 2 the results have been tabulated not according to the number of operations but according to the number of children. Naturally these appear to better advantage because only the final result has been evaluated. Only those cases in which treatment was completed at least 6 months ago have been included. Therefore, children who have undergone operation five times are listed only once, i.e., the final outcome.

The results obtained in megaloureter without and with reflux and residual urine are good. Again, markedly poor results have been obtained in bladder neck obstructions. Five restorations resulted in one failure and three late deaths. The results in group 6—megaloureters with malformations, ureterocele, etc.—are favorable.

Those failures after uretero-neo-cystostomy and resection of the lower ureter (table 2, group 7) which have been partly corrected bilaterally by Boariplasty have responded satisfactorily.

The response in the relative few cases that were treated by conservative means has been unfavorable, with only 40 per cent finally cured.

Our experience emphasizes the fact that correction of urinary obstructions should be accomplished early in life, ideally between the first and the fifth year. Even though spontaneous restorations occur after simple conservative measures, improvement is relatively rare in serious urinary obstructions.

In cases of vesicoureteral reflux without real megaloureter, ostioplasty through the opened bladder is sufficient. We choose a deep inguinal

* J. Urol., vol. 85, 1961 (in press).

TABLE 1. *Results of 232 plastic corrections in megaloureters from 1953 to 1959*

	Number of Operation	Method of Operation	Cured	No Change	Deteriorated	+	Under Treatment	Unknown
1	50	Ostioplasty	41 = 82%	5 = 10%	1 = 2%		1	2
2	39	Resection of lower megaloureter (no reflux, no residual urine)	27 = 70%	4 = 10.4%	3 = 7.8%	1 = 2.6%	4	
3	46	Resection of lower megaloureter (with reflux, with residual urine)	34 = 73.8%	6 = 13%	3 = 6.5%		1	2
4	21	Operative resection of bladder neck and Y-plasty; electroresection	8 = 44%	5 = 27.5%		2 = 11%	5	1
5	9	Primary Boariplasty	3 = 33%				6	
6	11	Secondary Boariplasty	10 = 91%			1 = 9%		
7	3	Uretero-neo-cystostomy		2 = 66%				1
8	7	Resection of renal pelvis and shortening of ureter	5 = 72%				2	
9	5	Reduplication of ureter resection of lower megaloureter, uretero-ureter anastomosis	4 = 80%	1 = 20%				
10	3	Ureterocele, resection with shortening of ureter and ostioplasty	2 = 66%	1 = 33%				
11	4	Splitting of ureterocele in megaloureters	3 = 75%				1	
12	6	Heminephrectomy and ureterectomy	6 = 100%					
13	5	Primary ureteronephrectomy	4 = 80%			1 = 25%		
14	2	Secondary ureteronephrectomy	2 = 100%					
15	13	Other operations	12 = 92%					1
		Out of 232 operations	161 = 70%	24 = 10%	7 = 3%	5 = 2%	20	7
	7	Conservative treatment: ureter bougie, ureteromeatotomy, antibiotics	3 = 43%	2 = 28%				2
	6	Conservative treatment: bladder bougie, catheter, antibiotics	4 = 66%			1 = 16%		1

cut. The bladder is opened only one or two centimeters above the ureterostium. If, besides vesicoureteral reflux, a real megaloureter or a remarkable dilatation of the lower ureter is present, that is resected first.

Figure 2 demonstrates vesicoureteral reflux with dilatation of the lower right ureter before and after a plastic operation with resection of 4 cm. of the lowest portion of the ureter. (The technique of the operation on an 18-month-old infant is illustrated in my motion picture.)

In marked megaloureter without residual urine and without reflux, we resect the lower third of the ureter so that anastomosis and suture with the short distal ureteral stump without tension are possible (fig. 3).

In stenosis of the intramural portion, the ureter must be split and enlarged at the distal portion. In infants the results of these procedures are satisfactory. In children and adults, however, in spite of correct surgical performance, later stenosis is possible; in our experience it develops in from 10 to 15 per cent of the cases. Therefore, in children and adults we prefer to use Boariplasty, which we consider the best means of avoiding stenosis after uretero-neo-cystostomy or a failure of operation on the lower ureter.

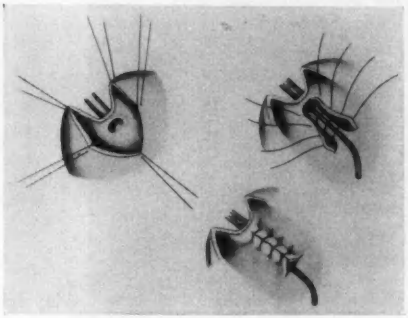

FIG. 1. Ostioplasty for removal of vesicoureteral reflux. Approach by low inguinal cut.

Figure 4 depicts the case of a 34-year-old woman with a bad result after nipple-plasty. Figure 4, *A* shows vesicoureteral reflux and *B* shows stenosis of the ureterovesical junction. The kidney was badly infected and the patient had recurrent attacks of fever. *C* is an intravenous urogram 6 months after Boariplasty. The infection and reflux have disappeared, and the patient has been cured.

Rarely does vesicoureteral reflux occur after Boariplasty, but it can be corrected without difficulty by ostioplasty.

Figure 5 illustrates the technique of Boariplasty in a case of stenosis of the lower ureter. In megaloureters with serious renal decompensation, and in the presence of high nonprotein nitrogen and disturbance of electrolyte balance,

TABLE 2. *Results of plastic correction in 96 children under 14 years with megaloureters from 1953 to 1959*

		Operative Treatment of	Results	a	b	c	d + e		f	g		
				Cured	No change	Became worse	Operative	6 months or more after the operation	Under treatment	Unknown	Temporary Cystostomy	Temporay Nephrostomy
1	9	Vesicoureteral reflux without residual urine		8					1			
2	18	Megaloureter without reflux		13	1			1	3			
3	27	Megaloureter with reflux		19	4			1	2	1		
4	17	Megaloureter with reflux and obstruction of vesical outlet		5		1		3	2		7	1
5	11	Megaloureter with reduplication of kidney, horseshoe-kidney, ureterocele, without obstruction of vesical outlet		9					1	1		
6	2	Megaloureter with obstruction of vesical outlet		1	1							1
7	11	Megaloureter with reflux or stenosis *after* plastic operation, secondary Boariplasty		7					4		2	2
8	2	Other operations, nephro-ureterectomy		2								
	91	91 children treated by operation		64 = 70%	6 = 6.6%	1 = 1.1%		5 = 5.5%	13 = 14.3%	2 = 2.1%	9	4
	5	Conservative treatment only		2 = 40%	2 = 40%			1 = 20%				

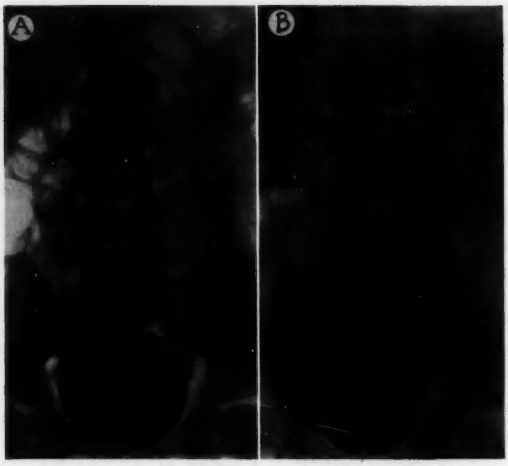

FIG. 2. C. P., girl aged 18 months. Ureteral dilatation with vesicoureteral reflux on left side; right side healthy. *A*, cystogram before ostioplasty; *B*, 4 years postoperatively.

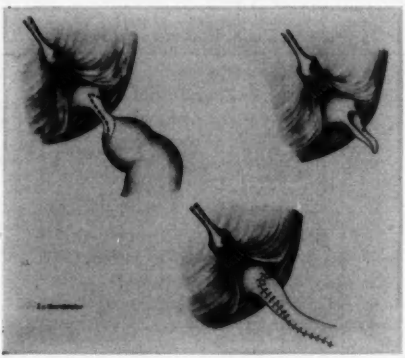

FIG. 3. Section of lower third of ureter and reunion of narrowed proximal ureter with distal ureteral stump and extension of strictured intramural segment of ureter.

Boariplasty is superior to all other methods because provision of urinary drainage by utilization of large caliber splints makes nephrostomy unnecessary. (Such a case is depicted in the third part of my motion picture.) The patient was a 6-year-old boy. Six months ago, because of obstruction of the vesical outlet, cystostomy was necessary. Because of numerous kinks of the megaloureter urinary drainage is unsatisfactory. After Boariplasty on the worse side, the electrolyte balance became normal and the nonprotein nitrogen level dropped.

Figure 6, *A* shows the cystogram before operation (taken from the intravenous urogram) of a 30-month-old boy with bilateral vesicoureteral reflux. *B* depicts the cystogram 6 months after left ostioplasty and *C*, the right intravenous urogram. *D* was made 1 year later (18 months after ostioplasty). It shows that straightening of the right ureter had been successful, but that removal of vesicoureteral reflux was not successful. Heavy infection in the right kidney persisted and because the function of the left kidney returned to normal after 6 months, right uretero-nephrectomy was carried out, successfully.

Another case (fig. 7) is a 4-year-old boy with bilateral megaloureter because of bilateral stricture of the intramural portion. Moreover, two stones were found in the right kidney and one in the right ureter. Intravenous urography 5 months after bilateral resection of the lower third of the ureter and removal of the stones showed good renal function.

A case of megaloureter is demonstrated in figure 8, *A* before operation and in *B*, 3 years after resection of the lower third of the right ureter.

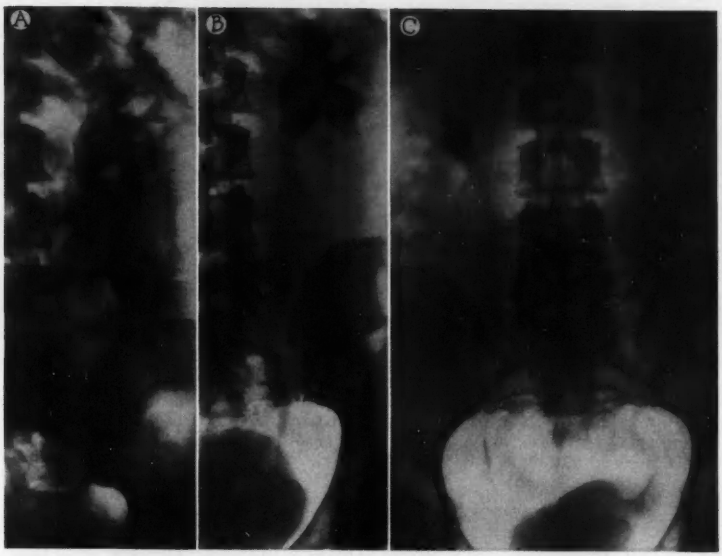

FIG. 4. L. R., woman aged 35. Secondary stricture with vesicoureteral reflux after nipple-plasty. *A*, cystogram. *B*, intravenous urogram before Boariplasty. *C*, 6 months postoperatively.

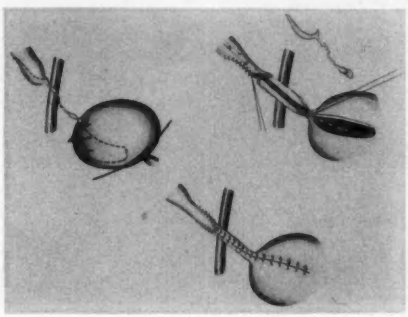

FIG. 5. Technique of Boariplasty for bridging over lower ureteral segments because of secondary stricture after uretero-neo-cystostomy.

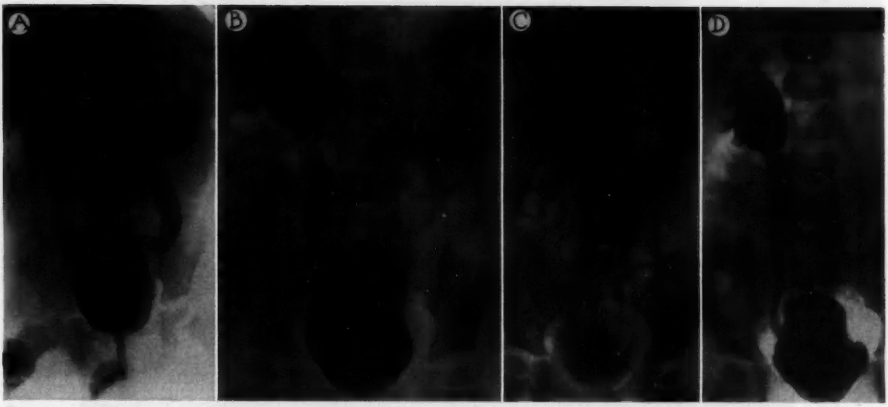

FIG. 6. M. F., boy aged 30 months. Obstruction of vesical outlet, vesicoureteral reflux, renal rickets. *A*, cystogram after 3 months of continuous catheter treatment. *B* and *C*, after shortening of lower left ureter and ostioplasty. *D*, cystogram 6 months after shortening of right ureter and right ostioplasty. It had been impossible to eliminate reflux on right side.

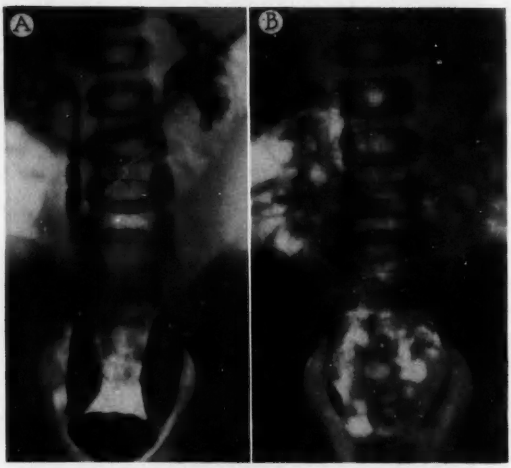

FIG. 7. A. B., boy aged 4 years. Bilateral ureter with stones in right kidney and right ureter because of congenital stricture of both intramural ureteral segments. *A*, retrograde pyelogram before bilateral resection of lower third of ureter and removal of stone from right kidney by pyelotomy. *B*, intravenous urogram 5 months postoperatively.

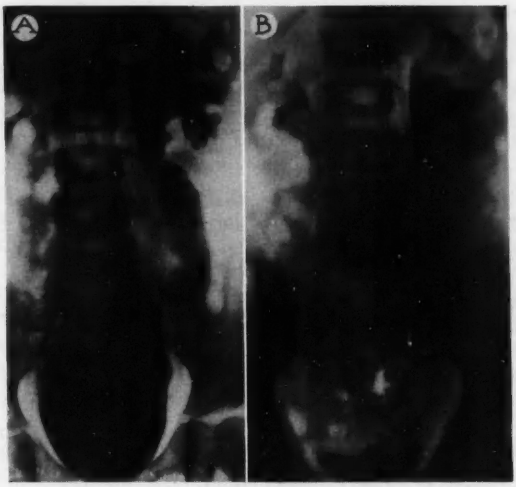

FIG. 8. B. M., girl aged 3 years. Primary left megaloureter without reflux; right side healthy. *A*, before resection of lower third of ureter. *B*, 3 years postoperatively.

SUMMARY

In my opinion, obstructions of the lower ureter are always mechanical in origin except those due to disturbances and malformations of the central nervous system. They must be removed as early as possible by plastic correction. In infants, resection and respective shortening of the lower ureter, eventually with removal of a stricture, is recommended; in cases of reflux, ostioplasty.

In adults, resection of the lower ureter with utilization of the original ostium is not unobjectionable because of the possibility of development of fistulas and secondary strictures. It should be replaced by Boariplasty which for all unsuccessful operations on the lower ureter is the method of choice and produces good results.

The results of ostioplasty for bladder neck obstructions are unsatisfactory, especially in those cases of neurogenic obstructions.

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WHEN SHOULD THE CHILD WITH REFLUX BE OPERATED UPON?

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In considering the question of what to do about ureteral reflux in children, the most pressing problem is how to determine when is it necessary to operate upon these patients. Antireflux operations on the lower end of the ureters are not without risk. After such operations, the lower ureters are sometimes deprived of blood supply and will stricture, with further damage and possible loss of the kidney. On other occasions the operations are failures and reflux continues. In the case of operations on the bladder neck in female children, it is possible to cause incontinence or fistula into the vagina. In male children we do not know how many instances of sterility may result from unnecessary operations on the bladder neck, causing reflux of semen. Certainly these operative procedures are not to be taken lightly and should be reserved for the situation in which they are clearly indicated. Furthermore, we must know what can be accomplished by conservative methods, such as periodic dilations of the bladder neck, before we can judge how much of our success is truly due to the operation or how much could have been accomplished by conservative measures, plus the growth of the child's urethra. We must remember that the diameter of the child's urethra is growing larger with every passing month and that very slight increases in the diameter of the urethra bring about substantial decreases in the resistance of the bladder outlet. The volume of urine which can be passed through the urethra increases as the fourth power of the radius, which is a very real increase. In any case, if we can help the diameter of the urethra to grow, keep strictures from contracting and keep infection subdued, time is on our side. On the other hand, if a fairly foolproof operation can be devised and if it will bring about immediate clearing of the entire situation, this may, after analysis of everyone's statistics, turn out to be clearly better than prolonged conservative treatment. It is the object of this and other studies to contribute to the fund of knowledge which may make the answer to this question more obvious. It appears to us that our next quest must be for more foolproof diagnostic tests which will measure the success of our therapy and tell us when conservative therapy is not sufficient.

BLADDER OUTLET RESISTANCE

A relative increase in the resistance of the bladder outlet was a large factor in a majority of our cases. Furthermore, reflux was often reversible following any measures which were effective in expanding the bladder outlet in these cases. This was true whether the cause of the trouble was a large caliber stricture which was difficult to demonstrate, or a severe stricture with trabeculation and residual urine, or "valves" of the posterior urethra, or the dilation of the urinary tract associated with deficiency of abdominal musculature or to obvious neurogenic causes. Certainly there were different degrees of severity of each of these conditions.

We were trying to determine which children we must operate on to open up the bladder outlet, or to do antireflux operations upon, or divert the urine into an ileal conduit and which children we could tide over with dilations of the urethra until the urethra grew large enough to reduce the pressure necessary to empty the bladder. With these objectives in mind we reviewed some 200 of our children with ureteral reflux who had had only procedures to open up the bladder outlet, in order to determine what information we already had on this subject. Of these children there were 148 where there was sufficient information for statistical purposes and among these, 70 per cent had an obvious stricture of the bladder neck. Sixteen per cent had obvious neurogenic bladders of various degrees. An additional 14 per cent could not be classified, since this was a retrospective study. It was apparent that there were more cases of reflux in female children than in male children (102 females versus 88 males) but that the severe cases of reflux were much more common among males (56 per cent) than in females (32 per cent). This was not surprising, in view of the longer male urethra, with more opportuni-

ties for points of obstruction. We were also struck by the fact that very few Negro children demonstrated reflux, in this group: only 7 Negroes out of a group of 190 children with reflux, while the proportion of Negro children in our ward population is far greater than this. A few children in this group would qualify in the "megacystis" classification, as suggested by Innes Williams, but the cause of these large, thin-walled bladders with reflux was not always the same. Some of them were due to very tight strictures of the urinary meatus, and both the reflux and the enlarged bladders were relieved by simply opening up the urethral meatus.

There is a tremendous variation in the degree of impairment of drainage of the urinary tract from one child to the next, and we have come to realize that even the most minor of increases in the bladder neck resistance may bring about recurring infections which will not respond to chemotherapy alone. Dilatations of the urethra must be added to the treatment regimen or the patient will be very slow to recover. Indeed, if the bladder neck narrowing is severe, or the dilatation severe, very vigorous dilatations of the bladder neck may be required, and on a regular schedule. Conservative treatment (dilations plus chemotherapy) is surprisingly effective in opening up these narrow areas, especially in females, and time is working with the doctor, since with every passing month the urethra is growing slightly larger in diameter. It is the duty of the physician to keep the child's urinary tract out of trouble with antibiotics, dilations and supportive therapy, while the urethra grows larger. Once it reaches its full growth, the urinary tract may arrive at a state of balance, if meanwhile, damage from infections and hydraulic pressure can be minimized. Studies such as those of Knappenberger have demonstrated that chemotherapy alone is not sufficient to control this type of disorder while the child is growing larger, but that dilations, along with chemotherapy are essential. The fact that we have at our command chemotherapeutic chemicals, such as the sulfa drugs and nitrofurantoin, makes it possible for us to prescribe prolonged low dosage therapy without much hazard of the development of drug resistance. The stronger antibiotic drugs can be held in reserve to cope with acute attacks as they may occur. It has been demonstrated that in children, very severe dilatations of the urinary tract may respond to conservative dilations of the urethra on a schedule of every four to six months, done in the hospital, with anesthesia, so that adequate dilation can be accomplished. This avoids the severe psychic trauma which attends efforts to dilate these children in the office. If there is severe trabeculation of the bladder, and if the response to conservative treatment is not satisfactory, transurethral resection of the bladder neck or, better still, open plastic revision of the bladder neck, by the Y-V type of operation, will relieve more severe obstructions effectively. If conservative therapy, directed at reducing the bladder neck resistance, is not sufficient to cope with ureteral reflux which has been already too well established, it may eventually be necessary to do an antireflux operation on the ureterovesical junction. This is best done before the ureters become too large, lest the oblique insertion of the ureter through the bladder wall fail to be competent. It is our opinion that conservative treatment should be given a fair trial, however, before operation is attempted on the lower end of the ureter. Occasionally, the lower end of the ureter will slough or become strictured and the kidney will be worse off than before. The approach to such operations should be taken with all recognition of the possibility of a serious complication. This group of children, with "strictures" of the bladder neck, vary greatly in severity but those with a very mild large caliber stricture, which often go unrecognized, are by far the most common. Strictures accounted for 70 per cent of our cases of children with dilated tracts. Of these, again the most common type is that where only a subtle difference from normal in the bladder neck resistance exists. Therapy is mechanical and ranges anywhere from dilation through transurethral section, to open Y-V revision of the bladder neck.

NEUROGENIC BLADDER

Dilatation of the urinary tract can also occur, in a much smaller proportion of patients (16 per cent in this series), from obvious neurogenic causes. The most common cause is meningocele, with either a modest or severe bony defect. Some of these patients have no sacrum whatsoever. Not all of these patients are hopeless, by any means. There is a great variation in the degree of severity, ranging from very modest neurogenic

deficiencies, which are well compensated either with or without a small operation to reduce the bladder neck resistance, through more severe degrees of neurological damage which may require urinary diversion. Among these cases, a period of catheter drainage may be necessary for many months before the true state of the urinary tract can be appreciated. Sometimes the urinary obstruction due to a too high resistance of the bladder neck can be relieved by an indwelling catheter while the patient (and his urethra) are small. We have had some patients where this catheter has been left in place until the child has reached its growth. Then the catheter could be removed because the urethra had grown large enough to accommodate the urinary outflow without trouble. Conservative dilations and "low pressure" triple voidings have helped a surprising number of these patients with mild neurological bladders. In other children, it has been necessary to do diverting operations, leading the urine either into nephrostomy tubes, permanent ureterostomy tubes, or an ileal conduit, emptying into a device which could be glued in over the end of the urinary stoma at the belt line. The percentage of patients with severe neurological deficits who can be helped by an operation to lower the bladder neck resistance is probably not quite as great as the percentage of severely afflicted patients whose urinary tracts ultimately require diversion of the urine to an artificial device. Plastic operations on the bladder neck certainly do not work too well in this severe group. The neurosurgeons continue to experiment, seeking methods for reducing the bladder neck's resistance (as by cutting the pudendal nerves). To date, these operations have had very limited application and the results tend to be temporary.

TRACTION SYNDROME

A very small group of meningocele patients have come to us with a history of having a meningocele repaired immediately after birth. Then as the child has grown older, urinary symptoms which were not present before have begun to appear, and a dilated urinary tract has been discovered. In some of these patients, it has been found that the tip of the spinal cord was bound down into the scar of the old meningocele operation and as the child grew larger, the nerves of the cauda equina were put on the stretch because they could not assume their normal position, due to the traction on the filum terminale of the spinal cord. In these few selected cases, it has been possible to cut this adhesion and permit the end of the spinal cord to spring up toward a more normal position. This has relieved tension on the nerve roots and has resulted in improved bladder function in several of our patients. This work has been pioneered by Dr. James B. Campbell of the neurosurgical service. The criteria for selection of these patients are rigid.

CONGENITAL DEFICIENCY OF ABDOMINAL MUSCULATURE WITH DILATATION OF THE URINARY TRACT

Here again, a small group of patients have dilatations of the urinary tract in association with flaccid musculature of the abdominal wall. It has been postulated that this dilatation might be due to the lack of counterpressure over the abdominal wall or, conversely, that the lack of musculature in the abdominal wall over the bladder area might be due to pressure from the enlarged bladder. Neither of these postulates appears to be valid because of the fact that some cases have been found with absent abdominal musculature and normal urinary tracts. On the other hand, the usual finding is to discover a severely dilated urinary tract with extensive damage to the ureters and kidneys. In a large percentage of these patients the dilatation of the urinary tract has been due to a stricture of the bladder neck, often of the type known as valves, due to a membrane across the urethra distal to the verumontanum. This deformity suggests to us a failure of accurate union of the two ends of the urethra just distal to the prostate.

Regardless of the cause of the dilated urinary tract, the studies of Leuzinger and associates have revealed that a dilated bladder often acts as a cushion to protect the kidneys and ureters from the early occurrence of destructive reflux up the ureters. Also that once the ureters and kidney pelves become dilated, the urinary bladder may shrink and thereafter be more difficult to bring back to normal size and to reconstitute its ureterovesical valves. Thus, operations designed to reduce bladder size in these patients are of doubtful advisability. Other facts brought out by this study are the facts that in males the dilatation tends to be much worse than in females even though the total incidence of reflux is about the same, and that there are relatively fewer

Negro children with reflux and dilated urinary tracts.

SUMMARY

An analysis of the cases of 190 children with reflux and dilated urinary tracts revealed that stricture of the bladder neck accounted for 74 per cent, neurogenic causes 16 per cent and unclassified causes 14 per cent. While reflux and dilatation were more common in females, the obstructions which were found in the male patients were usually much more severe, possibly due to the longer urethra with its more frequent points for the possible development of obstruction. Of 102 female children with reflux there were only 32 per cent severe dilatations whereas among 88 male children there were 56 per cent severe dilatations, a significantly greater percentage of serious dilatations among the males. Conservative treatment in the form of systematic dilatations of the urethra, plus chemotherapy, was surprisingly effective in improving reflux and reducing the amount of dilatation of the urinary tract. Among the stricture cases, dilatations brought about 44 improvements and left no patient without improvement. Transurethral resection of the bladder neck brought about improvement in 8 cases but no improvement in 7 cases. Plastic operations to revise the bladder neck brought about improvement in 4 cases and no improvement in 8 cases. Likewise, among the patients with neurogenic bladder, nonoperative methods brought about 15 satisfactory results whereas only four showed no improvement. Transurethral resection helped in the one case where it was used and open operation on the bladder neck helped once but failed to help two other patients with this condition. Operations on the bladder neck have been notoriously unsuccessful in helping patients with neurogenic bladder and it is in this group where diversion of the urine to an ileal conduit is most often necessary for intractable situations. The severity of the degree of dilatation and reflux influenced the success of treatment in both groups. In the stricture group, among the patients with only mild dilatations, there were 25 satisfactory results and one unsatisfactory result from all methods of treatment designed to lower the resistance of the bladder neck. With severe dilatations there were 38 satisfactory and 32 unsatisfactory results. Among the neurogenic cases those with mild dilatations had satisfactory results from therapy to open up the lower bladder neck resistance whereas only one had an unsatisfactory result. In the severe dilatations among the neurogenic children there were 11 satisfactory results and only 2 that were unsatisfactory.

A large bladder appeared to act as a cushion to protect the dilated ureters from the excessive pressures generated in a small or normal-size bladder. This was evidenced by the statistics which showed that among the patients with large bladders, 51 improved whereas 20 did not improve; whereas among those patients with small bladders only 18 improved and 13 were unimproved. This was a significant difference in favor of greater ease of improvement in patients where there was a large bladder present to absorb some of the pressure and thus spare the dilated ureters and kidneys, permitting recovery to occur more easily.

An analysis of the records of those patients who died with dilatation and reflux of the urinary tracts showed that children with the following combination usually died. These were male children with multiple points of obstruction in the urinary tract (i.e. bladder neck plus ureteropelvic junction), elevated blood urea nitrogen determination when first seen, bilateral reflux, urinary infection and tortuous ureters.

From a study of the rapidity of recurrence of infections of the urinary tract in a group of children with contracted bladder necks, it became apparent that a combination of dilatation of the bladder neck plus chemotherapy was more effective than chemotherapy alone, in slowing down the recurrence of infections. In one group, the infections occurred only once every 10 months on the average, whereas they had been occurring once every month, prior to the institution of dilatations in addition to the chemotherapy. Thus it seemed apparent that not only were dilatations definitely beneficial for these children with dilated urinary tracts and reflux, but that the results of nonoperative therapy (i.e. dilations plus chemotherapy) were much more effective as a therapeutic tool than had been anticipated. These children should have a urethral dilation and a thorough checkup every 6 months, to make sure the dilatation is receding and infection is absent. If it is not, then operative means of reducing the bladder neck resistance must be employed.

The necessity for adequate therapy to tide over the small child who has an increase in the bladder neck resistance, during the years while his urethra is growing larger as his body grows, is essential. A fair test of conservative therapy should be given before resorting to operative methods. It should be remembered that time is on the side of the doctor and if the child's urinary tract can be kept out of trouble from infection and hydraulic back pressure the urethra will grow progressively larger until a state of satisfactory balance may be achieved by the time of puberty. This concept and its realization will, we hope, be taken into account in treating this condition until better tests are devised to determine which children must be operated upon and which children will respond to conservative treatment.

The help of Drs. Leuzinger, Knappenberger, Justice, Miss Cornelia B. McCoy and the Department of Medical Illustration of the Kingsbridge Veterans Administration Hospital, whose residents participate in this program, is acknowledged with appreciation.

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DISCUSSION

DR. WILLIAM P. HERBST, JR. (Washington, D. C.): I would like to ask a question. Dr. Lattimer, one of the neurological surgeons several years ago presented a paper before this society describing his operative attack on meningocele. I wonder whether in closing you would comment on what the trend has been in that area.

MR. EDGAR R. REAY (136 Glendory Road, Christchurch, New Zealand): We have been very interested in this subject. What I think we need more than anything else is some clear thinking on it.

I believe there are two definite groups, and that we have to put the patients into one of these two groups. First of all, the definitely obstructed type; second, the definitely functional type.

We follow very closely the teaching of Innes Williams in Britain on this second group. Dr. Lattimer has slipped a little bit. He talks about the "imperceptible" stricture. We think the patient either has a stricture or does not have a stricture.

We regard the second group as functional, and I think myself it is due to a defect in the afferent arc. These two don't seem to have the proper sensation in the bladder.

I brought a few slides to show you on the subject.

(Slide) The first thing to do is to have a good radiologist in this business. I think these cases are very common. This is the setup in dealing with these children.

The first point is that you do not want a lot of radiation given to young children. We take only three films altogether—a plain film at the beginning, one film during micturition, and one film afterward. All the rest are done with the image intensifier.

(Slide) The micturition cystogram came to us from Sweden. We use this constructed set with a Bucky diaphragm behind.

(Slide) For the micturition cystogram the child sits on this seat, with the right leg over the chair so that you get a slightly oblique film. This is an actual picture of micturition going on. You don't often have a picture showing female micturition. It is an extraordinary situation when you first see it. (Laughter) It is an extraordinary spraying effect.

(Slide) The first thing is to get some clear ideas about whether there is obstruction or whether there is a functional bladder. In the obstructed bladder generally, in the intravenous pyelogram, the movement in the ureter is rather sluggish, and there is nearly always a hold-up in the lower ureter. We regard that sign as very informative.

In the intravenous pyelogram in the obstructive case in children there is nearly always a hold-up in the lower ureter, whereas most children's ureters clear very rapidly.

(Slide) Here is the ordinary micturition cystogram as Dr. Lich showed yesterday. Here is the obstruction at the bladder neck, and the dilatation beyond the stricture in the female urethra.

(Slide) Here is another thing Dr. Hamm drew attention to. Here is a grossly obstructed bladder. This is a case of valves, but here again you see that secondary obstruction at the bladder neck is due entirely to hypertrophy of the detrusor muscle, with a purely secondary effect.

There is no use taking that thing when you have obstruction down in the posterior urethra. This was a case of valves with a secondary obstruction due to trabeculation. This was a mixed case.

(Slide) When you get to this stage you are getting into trouble in your differentiation of the two types. This was a child 1 year of age who was admitted as an abdominal emergency and who had this enormously dilated bladder with this great reflux here. A micturition cystogram showed a definite stricture at the bladder neck. This enormous bladder was absolutely paper thin, but a VY-plasty was done on this bladder neck and the whole thing resolved beautifully.

That is the end stage of obstruction when you have atony supervening on trabeculation and you have a complete reflux. At this stage it is very difficult to distinguish between the other functional type.

(Slide) Here is what is described as a megalocystis or megaloureter type, a different thing altogether. Here is the intravenous pyelogram, with moderate dilatation of the pelvis and large dilatation of the ureters. We always find that the

dilatation of the ureters is generally brighter than the dilatation of the renal pelvis and the cut-off here.

(Slide) These children with megacystis complex have a typical history. They micturate very often—twice a day. This child was quite comfortable with this huge accumulation of urine

(Slide) Here is a cystogram showing a reflux.

(Slide) It is a large, thin-walled type of bladder. Here is this child micturating. Curiously enough, once these children get around to it they will produce quite a good stream and they empty their bladder quite well.

(Slide) Here is the micturition picture with right reflux, the bladder emptying, nothing wrong with the bladder neck, quite a free bladder neck and quite a good stream.

(Slide) This is the final stage of micturition. The bladder has emptied completely. There is this great bulla of dye shot up into both ureters, and this is the type of case that gives you also residual urine.

In the obstructed case you get true residual urine. When you put the dye into the bladder after micturition, the bladder contains urine, but in these cases the ureter contains urine.

(Slide) Four or five minutes after micturition all that material has come down into the bladder, and you have a false residual.

In conclusion, what are we looking for in these cases? First of all, true or false residual urine; second, bladder capacity; third, trabeculation; fourth, reflux; fifth, ureteral movements.

In the obstructed cases ureteral movements are generally sluggish. In the functional types, as you all know, ureteral movements are wide. You can end peristalsis while there are ureteral movements.

Sixth, bladder neck and urethra.

I do think we have to have some clear thinking between the two types of cases.

Dr. Nesbit asked how I treat the last group. First of all, of course, we get the children onto chemotherapy and multiple voiding.

In the second group of functional cases we find that many of these children are frankly dirty when they come into the room. That is an observation we can make almost right through—that these female children, most of the children in this functional condition, are dirty in their perineum. When they are taught hygiene they generally improve. We simply go on with chemotherapy and try to get them to have a right way of thinking about their bladder function, and go on with multiple micturition.

I think the whole crux of the problem is to get these children early. I know that some of them will fall by the wayside and you will have to do these operations, but I really think if we can get this group earlier we can do some things simply by training and chemotherapy.

Dr. David M. Davis (Haverford, Pa.): I arise not to engage in a debate but rather to express a considerable degree of gratification at the renewed and growing interest in problems such as those that have been discussed this morning, and also to recall that about seven years ago I predicted that sooner or later this interest would arise and that we would develop a full-grown science of urodynamics. I think we are well on the way toward that now.

As I see these problems, it seems to me that the one remaining set of determination which we need in order to make our concepts really intelligent, as Mr. Reay has said, is the ability to measure pressures at any point in the urinary tract.

Certainly in the cases we have seen this morning if we knew what the pressure was in the pelvis, in the ureter and in the bladder simultaneously during cineradioscopic observations of ureteral peristalsis, then we would know all about the situation and would be able to treat such cases much more successfully.

Dr. John K. Lattimer (New York, N. Y.): I can only thank Mr. Reay for calling my attention to the fact that I should not have said "imperceptible" but should have referred to these as large-caliber strictures that are difficult to detect.

I think Dr. Lich's point was well taken, that there may be something there that we are not detecting up to now. I think many of us believe that by very careful inspection with the bladder greatly distended one may be able to make some of the obstructions of the bladder neck become evident as a circumferential ridge which can then be seen through the urethroscope. Some of the contractures of the bladder neck are very hard to find, and the empirical fact in our experience is that when you dilate the urethras to very large sizes the patients do better.

The second matter was Dr. Herbst's question

about our neurosurgeon, Dr. Campbell, who has made a hobby of trying to improve children who have neurogenic bladders which are due to adhesions of the filum terminale of the lower end of the spinal cord, which may have become stuck down in the sacral area as a result of an attempted meningocele repair shortly after birth. Then, as the child grows larger, since the lower end of the cord is pulled downward or held downward, the nerve roots are put on the stretch in an abnormal way, and as a result bladder function suffers.

The key to this syndrome is that the symptoms begin to appear (bladder symptoms and rectal control begin to get worse and worse) as the child grows older, and at age 6 or 7 many of them are brought to us with urinary problems. Actually, Dr. Campbell selects them very carefully on the basis of their urological work-up. He won't accept them if they are too far gone, for instance. He will require a long period of catheter drainage—a couple of years if necessary. He will require that the nerve function be still intact to an extent that will permit the perception of hot and cold in the bladder.

This is a very important point in his selection of cases. He has operated on about fifteen cases out of some 200 that we have surveyed, and two-thirds of these are doing surprisingly well. Their bladder function has increased; their rectal tone has done better. Some of them who had a little trouble with their legs walk a little better. In a very selected group he has had success. This is the current status of his work.

Dr. Peter Bischoff (Hamburg, Germany): We agree fully with Dr. Lattimer and Dr. Reay. It is only a difference in the material, not in the thinking. Dr. Lattimer, in his pediatric department, sees more early cases. Most of ours are advanced cases that come finally to our hospital after unsuccessful treatment elsewhere.

We operate upon only those cases that have been treated for a long time without effect; all the cases you have seen here were badly infected.

Only in one point I do not agree with you, Dr. Reay. We do not believe in so-called dynamic disturbances. I think all cases of urinary disturbance are at least mechanically caused, and when we cannot find an obstruction in all cases, it is because the embryonal obstruction might have been overcome later. In our opinion all the so-called dynamic disturbances are compensated stages of formerly fetal obstructions.

SURGICAL TREATMENT OF MULTIPLE, RECURRENT, BRANCHED, RENAL (STAGHORN) CALCULI BY PYELO-NEPHRO-ILEO-VESICAL ANASTOMOSIS

WILLARD E. GOODWIN AND ABRAHAM T. K. COCKETT

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The problem of recurrent, multiple, branched, renal calculi is not yet solved. Every urologist has seen patients with persistent or recurrent renal stones after previous surgery (fig. 1).

It seems to us that obstruction and poor drainage, with attendant infection may be one of many factors contributing to the reformation of such stones. Higgins found obstruction in 72 per cent of cases with recurrent calculi.[1] The usual removal of such calculi, no matter how meticulously done, does not always prevent further stone formation in some of these patients. Indeed, the areas of renal calcification are often multiple and so widely spread that nothing short of nephrectomy seems to rid the patient of the stone problem (figs. 2 and 3).

When the disease is bilateral, or when the patient has a history of having passed stones from both kidneys, or when the patient has a solitary kidney, nephrectomy is contraindicated. When obstruction is an important factor, recurrence of stones might be prevented by providing large caliber drainage to the bladder. If they did recur, they could pass without difficulty.

Our paper reports the use of an isolated loop of ileum to eliminate obstruction in 3 patients with this problem. The operation was designed to provide maximal drainage of the renal pelvis and lower calyces in such patients.

The genesis of this idea is interesting. It has taken about three and a half years for us to reach our present conclusion that this may be a valuable and safe method of dealing with the problem. The longest followup observation, on our first patient, is 2 years.

In January 1957, we saw a 16-year-old boy with a solitary left kidney and obligatory nephrostomy tube because of upper ureteral damage. The lower calyx of this kidney was filled with numerous tiny seed-like calculi (fig. 4). Attendant infection was present. In order to rid the patient of the nephrostomy tube, a segment of ileum was substituted for the damaged ureter. Subsequently, the nephrostomy tube was removed; and the patient has fared extremely well during the 3½ years since surgery. Followup x-ray studies (fig. 5) in April 1957, three months after operation, revealed that the stones had vanished.* The patient has no further evidence of calculi and remains in good health. The idea that perfect drainage provided by an ileac ureter

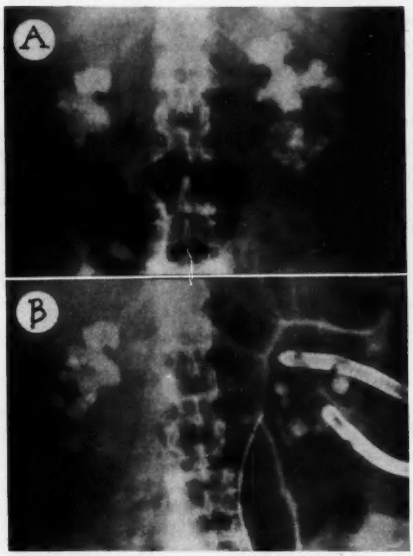

FIG. 1. *A*, example of bilateral, multiple branched (staghorn) renal calculi with obstruction at ureteropelvic junction. *B*, result of unsuccessful partial removal. Patient had far advanced renal failure and died within 6 months.

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[1] Higgins, C. C.: Factors in recurrence of renal calculi. J.A.M.A., **113:** 1460, 1939.

* This case included through the courtesy of Dr. Robert Prentiss, San Diego, Cal.

FIG. 2. Surgical specimen. Contracted kidney and multiple branched renal calculi. Note areas of calcification in renal parenchyma. When these are left behind, even after successful removal of major stone, recurrence is frequent.

FIG. 4. Close-up view of nephrostomy tube with nest of small, seed-like calculi in lower calyx of solitary left kidney. These calculi disappeared within 3 months after ileal ureter was used. Patient never conscious of passing them. Case suggested use of ileal ureter in management of patients with multiple recurrent calculi. (Courtesy of Dr. Robert J. Prentiss, San Diego, Cal.)

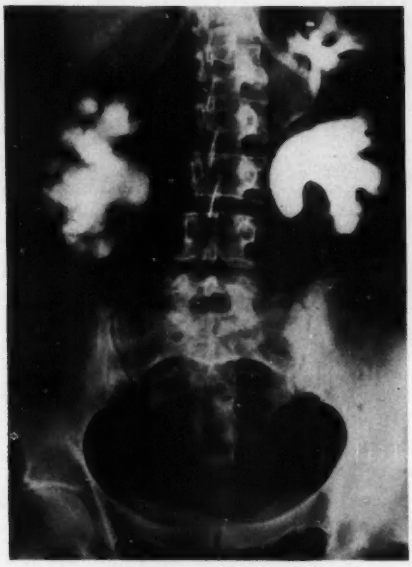

FIG. 3. Intravenous urogram, bilateral renal staghorn calculi. Note evidence of ureteropelvic junction obstruction in contour of stones. Note solitary functioning segment of duplicated kidney on left. Patient living on this segment. Because there was no serious obstruction here, no stones formed in upper segment. This seems to be clear demonstration of role of obstruction. (Courtesy of Dr. William W. Scott, Baltimore, Md.)

might be beneficial in such a problem occurred to us as we observed the results in this case.

In the summer and fall of 1957, we observed a patient with a solitary left kidney and far advanced renal and vesical tuberculosis. Bricker's operation was done to divert the urine to the skin by way of an ileac segment. Subsequently it became apparent that the ureteroileal anastomosis was not functioning properly, and the procedure was repeated. At the time of the second operation, in order to make an anastomosis, it was necessary to open the lower portion of the renal pelvis and the lower calyces of the kidney. The ileac segment was anastomosed directly to the renal pelvis and lower calyces. Ultimately, this patient died of advanced renal tuberculosis and renal failure. However, we learned that it was technically feasible to attach an ileac segment directly to the renal pelvis and lower calyces. Later, we treated a similar patient in the same way. She had a solitary right kidney and a poorly functioning ureteroileal anastomosis due to necrosis and stricture of the upper ureter. The kidney was explored, and the pelvis and lower calyces were carefully opened along the medial margin of the lower pole. The spatulated ileum was successfully anastomosed directly to the pelvis and lower calyces and has functioned well as a conduit to the skin ever since.

Shortly after this, the 41-year-old patient

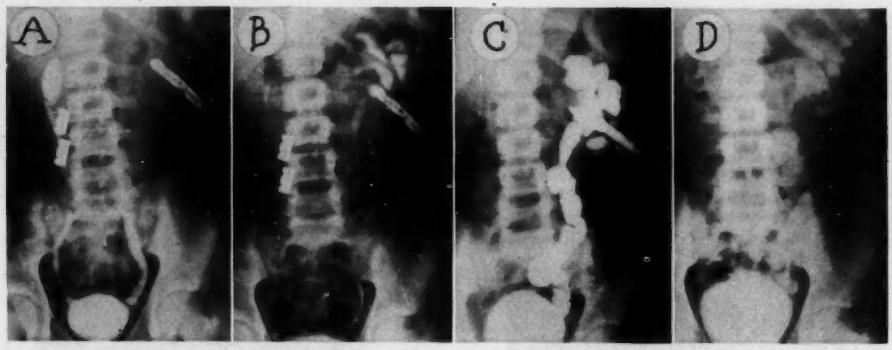

FIG. 5. Sixteen-year-old youth with solitary left kidney and obligatory nephrostomy because of damage to left upper ureter. *C* and *D*, successful result of use of ileal ureter. *C*, antegrade pyelogram made by filling nephrostomy tube. *D*, intravenous urogram.

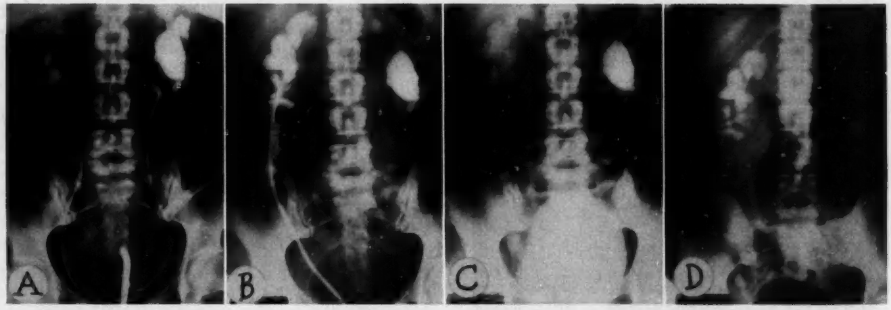

FIG. 6. Case 1. Forty-year-old woman with bilateral recurrent staghorn calculi. History of previous surgery on both sides. Calculous pyonephrosis on right with pain and episodes of fever. *A*, preoperative appearance of retrograde pyelography. Note ureteral obstruction on each side. *B*, *C*, *D*, postoperative result of substitution with ileal ureter on right side. Patient has been relieved of symptoms related to right side and is apparently now living on right kidney. Because of recurrent pyelonephritis and pain, left side subsequently treated by pyelolithotomy and vertical flap pyeloplasty.

whose x-ray films are shown in figure 1 came under our care. She had bilateral, multiple renal calculi with staghorn formation and far advanced renal failure. An attempt was made to remove the stones from the left kidney. However, as seen in the postoperative film, this failed. The patient expired after about six months of observation. In thinking of her case, we wondered if this could have been prevented. Perhaps if she had been treated earlier before renal failure developed, she might have survived if good drainage were provided at the time of removal of the calculi.

Ultimately, in May 1958, we had the first opportunity to test this hypothesis in a patient who seemed to fit the criteria we had begun to evolve for the procedure.

CASE REPORTS

Case 1. Mrs. E. R. (UCLA No. 015-44-46) was a 41-year-old housewife who had bilateral recurrent staghorn calculi. She had a history of having had three operations on the right kidney and one on the left. Roentgenograms revealed large, multiple renal stones with evidence of obstruction (figs. 6 and 7). She was young and in relatively good condition. Her blood chemistry values were nearly normal in spite of the advanced renal calculus disease. She had painful, recurrent, severe right pyelonephritis; the urologist who referred her had suggested that she might possibly best be treated by right nephrectomy.

On May 23, 1958, the operation shown in figure

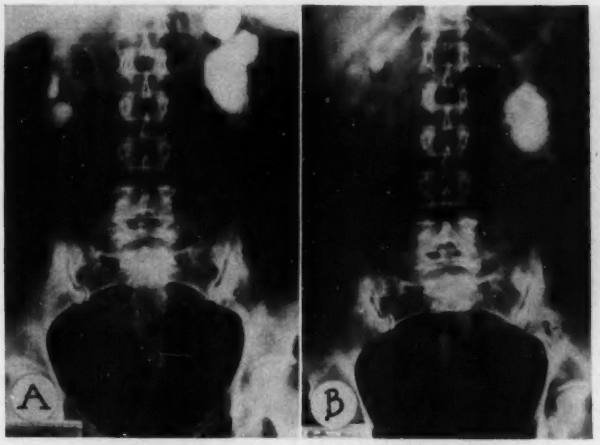

FIG. 7. Case 1. Pre- and postoperative intravenous urograms. Patient has now been followed 2 years

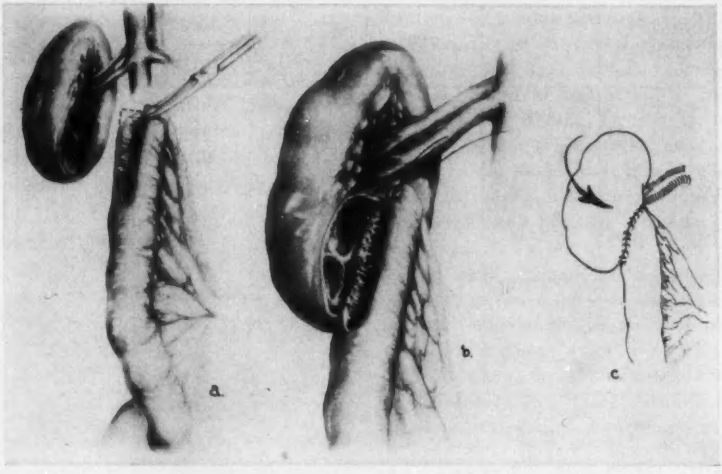

FIG. 8. Technique of pyelo-nephro-ileac anastomosis. Under direct vision, pelvis and lower pole of kidney are opened. Elongated, spatulated end of ileac segment is anastomosed to lower half of kidney. Mucosa-to-mucosa anastomosis is accomplished. Hemostasis is secured by transfixing mattress sutures. Ureter may or may not be removed.

8 was performed. It consisted of abdominal exploration and isolation of an ileac segment followed by reanastomosis of the ileum. The right kidney was explored and nephrolithotomy was done. The diseased ureter was removed, and a pyelo-nephro-ileo-vesical anastomosis was performed.

The stone proved to be calcium phosphate. The postoperative course was complicated by a wound infection and slow healing. However, the end result was dramatically gratifying. From that time forth she has had no further trouble with her right kidney. She was rid of the painful attacks of recurrent right pyelonephritis. In spite of the fact that after three previous operations for removal of stone from the right kidney she had reformed calculi, there has been no evidence of any recurrence of stones in this

TABLE 1. *Blood chemistry values, case 1 (Mrs. E. R. UCLA No. 015-44-46)*

Date	5/15/58	Surgery 5/23/58				Surgery 1/15/60					
		5/26/58	6/12/58	7/17/58	1/13/60	1/16/60	1/18/60	1/22/60	1/25/60	1/26/60	4/28/60
					BUN						
NPN	22	38	38	21	15					25.7	
Creatinine	1.1	1.75		0.8	1.3	2.8	2.2	1.8	1.5		1.7
CO_2	22.9	17.4	25	26.7	22.5	20.4	18.3			19	20.4
Cl	105	100.8	103		108	92	103			106	111
K^+		4.2	4.6	4.2	4.1	5.6	4.5			4.4	4.8
Na^+		133	140	139	140	128	132			136	141
Ca^{++}	5 meq/L				4.7						4.5
P	2.64				3.7						3.4
Uric acid	6.3										6.8
Total protein, albumin, globulin											7.1

TABLE 2. *Blood chemistry values, case 2 (S. B. VA No. 67618)*

Date	1/14/58	1/21/58	10/29/59	Surgery 11/9/59		
				11/13/59	12/15/59	4/26/60
Creatinine	1.4		1.6		1.2	1.6
CO_2				21.5	18.4	24.6
Cl				97	97	98
K^+						4.7
Na^+						140
Ca^{++} mg.%	9.7	10.6				10.2
Po_4	3.3	3.2				3.4
Uric acid	2.2	3				3.8
Total protein						7.4
Albumin						4.2
Globulin						3.2

kidney during the 2 years since surgery. Her blood chemistry values have remained normal (table 1).

Since at that time the patient was not having any symptoms related to the left kidney, it was elected not to operate on the obstructing staghorn calculus then, although we believed that it would ultimately be necessary.

During the 18 months she had several episodes of recurrent *left* pyelonephritis and finally the left kidney appeared to be nonfunctioning. In January 1960 the left staghorn calculus was removed and a vertical flap pyeloplasty was done. The postoperative course was uncomplicated, but it appears that this kidney is nonfunctioning or severely impaired. Although we had considered performing the same operation on the left side as had formerly been done on the right, we were reluctant to do this and thus increase the absorptive surface of the small intestine in contact with the urinary tract. Only time will answer whether or not this was a wise decision.

Two further cases have been treated in this way.

Case 2. Mr. S. B. (VA Hospital No. L.A. 67618) was a 44-year-old white man who had a history of passing numerous renal calculi (12 to 15 stones from each side) during the past 20 years. In 1947 he had a left ureterolithotomy; in 1956 he had a left pyelolithotomy, in 1958 he

was hospitalized because of right flank pain associated with fever and chills. Blood chemistry values were normal (table 2).

In October 1959, severe right flank pain with fever and chills developed. An intravenous urogram revealed a staghorn calculus on the right with small nests of calculi within the renal parenchyma. Several small calculi were present in the left kidney (fig. 9).

On November 9, 1959, the procedure shown in figure 8 was carried out. The staghorn stone and many of the smaller stones were removed from the lower pole of the right kidney, and the renal pelvis and lower pole were opened widely. The stones proved to be *calcium phosphate*. The spatulated end of the ileac segment was anastomosed to the renal pelvis and lower portion of the kidney. The ureter was removed, and the ileum was placed as a substitute ureter going to the bladder. Postoperative x-ray films revealed multiple small calculi still present in the parenchyma.

About one month postoperatively, the patient passed a rough calculus more than 1 cm. in its greatest diameter (fig. 10). This stone passed all the way from the kidney to the bladder (fig. 11) without the patient knowing about it until he had symptoms of discomfort when the stone irritated the trigone and vesical neck. He did not have renal colic. A similar episode occurred in February 1960 when he was readmitted to the hospital because of obstruction to urination during the act of voiding. Cystoscopy and litholapaxy of multiple *bladder* calculi were carried out. "Multiple tiny stones were removed by irrigation and the lithotrite. The stones ranged from about the size of small particles of sand to the size of small beans."

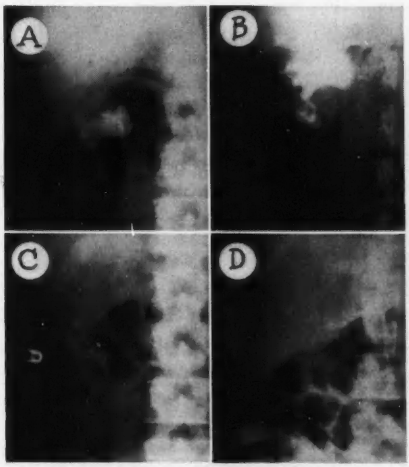

FIG. 9. Case 2. History of numerous renal calculi passed from both sides. *A*, staghorn calculus in lower calyces on right. *B*, intravenous urogram reveals hydronephrosis above obstructing stone. *C* and *D*, fragments of calculi left behind after attempted removal.

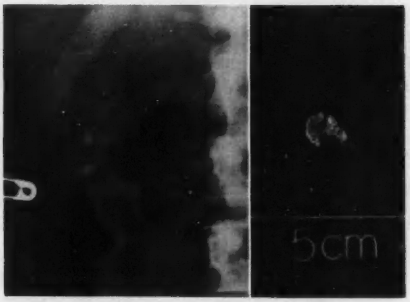

FIG. 10. Case 2. Note calculi left behind after surgical removal. At time of removal, ileac segment was substituted for ureter, as shown in figure 8. Lower of these calculi subsequently passed without patient's knowledge until bladder symptoms developed when calculus reached vesical neck.

Once again, the patient had passed numerous calculi from the kidney to the bladder without any knowledge of it because of the large caliber of the ileal segment.

The results of blood chemistry determinations are listed in table 2. Long term followup studies of this patient should be extremely interesting.

Case 3. Mrs. R. B. (UCLA No. 017-24-73) first came under our observation in March 1960. She was a 60-year-old school teacher with a life long history of renal calculi. She had a stone removed from the bladder when she was only 2 years old. She had a solitary right kidney with congenital absence of the left kidney. Right nephrolithotomy was performed in 1926. There were recurrences in 1933 and 1940, and each time she had had further renal surgery with removal of calculi. The nature of these calculi was not known at the time we saw her.

She had been in fairly good health from 1940 to the present, although it was noted that she had recurrence of renal stones with staghorn

formation in the lower calyces of the solitary right kidney. During the last year she noticed more and more discomfort with episodes of recurrent pyelonephritis.

On March 10, 1960, she had a severe attack of fever, chills, vomiting and right sided pain. The infection responded to treatment with streptomycin. By this time she concluded that something must be done.

When she was admitted to the hospital on March 27, 1960, x-rays showed a staghorn calculus with multiple smaller calculi occupying the lower portion of the right kidney. There was an abnormality of the ureter with obstruction at the ureteropelvic junction (fig. 12). Blood chemistry values were within normal limits.

On March 28, 1960, the multiple calculi and staghorn stone were removed from the right

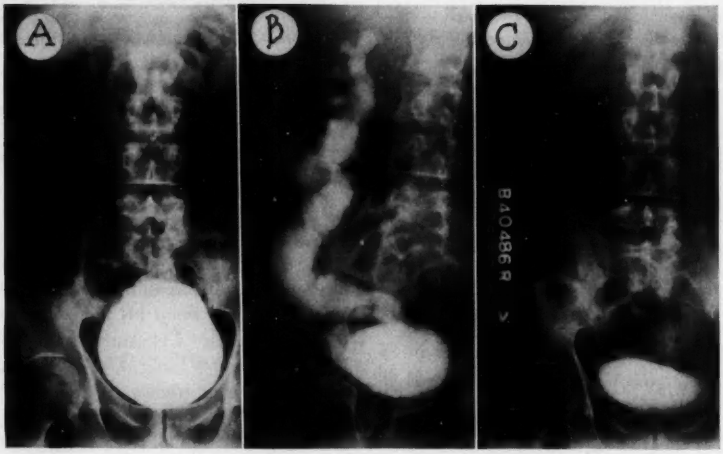

FIG. 11. Case 2. Postoperative cystogram. No reflux occurs until, as is seen in *B*, patient urinates. During act of micturition, reflux occurs. In post-voiding film it is seen that kidney empties promptly, but that patient has residual urine. Double voiding is necessary.

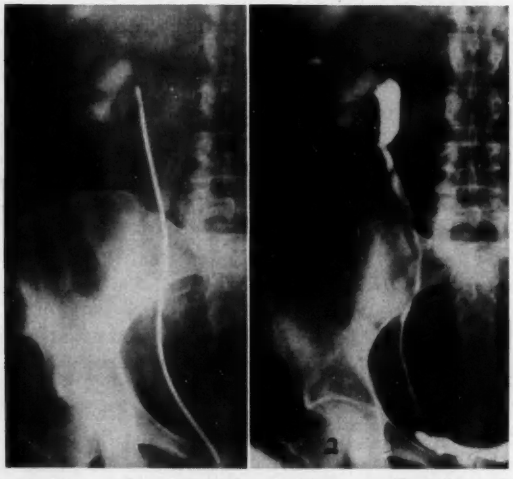

FIG. 12. Case 3. Preoperative roentgenograms reveal recurrent cystine calculi (patient had three previous surgical procedures on solitary right kidney. Note obstruction at ureteropelvic junction and also in upper portion of ureter.)

FIG. 13. Postoperative antegrade pyelogram made by filling nephrostomy tube by gravity. (Roentgenograms are made at one-half second intervals.) Note obstruction in upper ureter which allows small amounts of opaque material to get through. Ileac segment provides good drainage of lower pole. Cystostomy tube is in bladder.

kidney, and right pyelo-nephro-ileo-vesical anastomosis was performed. In this case it was decided to leave the right ureter intact because this was a solitary kidney. Her postoperative course was uneventful. Postoperative films made while the nephrostomy tube was still in place show residual obstruction in the right ureter with good drainage down the ileal segment (fig. 13). It was evident that one stone had been overlooked and lay in one of the calyces. If it should ever move it would easily pass down the ileal segment.

Analysis of the stone postoperatively revealed that it was cystine. This had not been suspected before surgery. However, at the time the stones were removed, they had the typical "maple sugar" appearance of cystine calculi. It is quite likely that this accounts for the patient's history of multiple stone formation. She was placed on a special diet to try to make her urine alkaline and to control further stone formation. Postoperative blood chemistry values remained normal. The postoperative phenolsulfonphthalein output was 41 per cent in 2 hours as compared with the preoperative output of 31 per cent in two hours.

DISCUSSION

The first patient, who has been followed for 2 years since surgery, is the only one observed long enough to justify a feeling of security that this operation accomplishes what is intended. The good result in the first case led us to perform the procedure in the second and third patients. Long term evaluation will be necessary in order to be certain of the wisdom of this type of procedure.

At present, our criteria for the use of this procedure are as follows:

The patient should be in good general condition and have a history of multiple recurrent renal calculi with previous surgery which has not prevented recurrences.

The patient's blood chemistry values must be within normal limits.

From previous experiences with the use of the ileac ureter, we have learned that it is probably not safe to use it when there is advanced renal insufficiency because absorption of urine from the ileac segment under these conditions is enough to cause progressive uremia.

Hyperparathyroidism must be ruled out in all patients with recurrent urinary calculi. Likewise uric acid and cystine calculi must be considered and ruled out.

We believe that the disease should be bilateral, as in cases 1 and 2, or in a solitary kidney as in case 3. It may be that at some later time this type of management could be recommended as the primary form of treatment in patients who have evidence of multiple renal calculosis and obstruction.

We are experimenting with the use of gastric grafts to the urinary tracts of animals in order to provide constantly acid urine to combat infection and stone formation.

TECHNIQUE

In an attempt to allow perfect drainage of the renal pelvis and the lower half of the kidney, the ileac segment is anastomosed directly to the renal pelvis and the lower calyceal complex. This is done by opening the lower portion of the kidney along its medial surface from the renal pelvis extending downward toward the lowermost posterior calyx. In effect, this opens the whole lower half of the kidney and the pelvis and provides dependent drainage without obstruction.

When the kidney still has good blood supply, it may be necessary to control the renal artery during this procedure in order to operate in a bloodless field. When it is necessary to occlude the renal circulation, it is better to place a small bulldog clamp on the renal artery alone rather than occlude both artery and vein. A rubber band tourniquet isolating the lower pole of the kidney may also be used to advantage for temporary control of hemorrhage.

If there is troublesome bleeding from the renal substance itself when the kidney has been opened, it can be controlled with interrupted mattressing sutures of fine catgut. After all bleeding has been controlled, the spatulated upper end of the ileac segment is anastomosed directly to the wide open renal pelvis and lower portion of the kidney. This is done by using a continuous running suture of all layers of the ileum to the open edges of the renal pelvis and lower calyces. The opening in the ileum should be on its antimesenteric border. The widely opened end of this ileac segment is molded into the renal pelvis and lower calyces forming a funnel shaped drainage canal. It is mandatory to do the anastomosis in such a way that the mucosa of the ileum is in contact with the mucosa of the renal pelvis and lower infundibulum and calyces. Splints are not necessary. However, a nephrostomy tube should be used for diversion during the postoperative period. The area should be well drained.

Anastomosis of the distal end of the ileac segment to the bladder is performed as described previously[2, 3] under direct vision from inside after removing a button of the bladder. The bladder is drained by cystostomy during the postoperative period.

SUMMARY

The problem of recurrent, multiple, renal calculi with staghorn calculus formation is discussed.

The role of obstruction in keeping alive infection and contributing to recurrent calculus formation is examined and discussed.

It is proposed that patients who have good renal function and are in good general condition, except for recurrent multiple calculi and staghorn stone formation, may be candidates for the creation of a large drainage conduit from the renal pelvis and lower calyces to the bladder to allow perfect drainage and facilitate passage of any further stones that may be formed or any fragments left behind.

The genesis of this idea is described.

A report is presented on 3 patients in whom this procedure has been successfully used. One of these patients had a solitary kidney.

The technique of the operation is briefly discussed.

CONCLUSIONS

Obstruction, either in the ureter or at the ureteropelvic junction, seems to play a contributing role in some cases of recurrent, multiple renal calculi with staghorn stone formation and infection.

Patients who have this situation with a history of previous operations and multiple stones and evidence of grave recurrence, may be candidates for the operation of pyelo-nephro-ileo-vesical anastomosis to provide improved drainage.

Any patient who is considered for this procedure must have good renal function. It would not be applicable to far advanced cases with evidence of uremia.

This procedure has been successfully employed in 3 patients with multiple recurrent renal calculi and staghorn stone formation. Present favorable results justify cautious optimism regarding its usefulness. It should be tried further and carefully evaluated.

[2] Goodwin, W. E., Winter, C. C. and Turner, R. D.: Replacement of ureter by small intestine: Clinical application and results of ileal ureter. J. Urol., **81:** 406, 1959.

[3] Goodwin, W. E.: Replacement of ureter by small intestine, The Ileal Ureter, in Modern Trends in Urology, edited by Sir Eric Riches. London: Butterworth, 1960, chapt. 16.

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DEVELOPMENT AND OPERATION OF A DIALYSIS UNIT ON A UROLOGICAL SERVICE

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The purpose of our paper is to discuss not only the establishment and functioning of the hemodialysis unit of the University of Michigan Hospital, but also to review the series of patients managed during 1959. The experience gained from this unit has proven to be a great asset in the urology residency program.

HISTORICAL EVENTS

The hemodialysis unit was established in the University Hospital as a part of the urology service in 1957. Although several abortive attempts had been made to establish such a unit by the department of internal medicine, it was considered that the urology service would be ideal because of an inherent interest in renal physiology and the surgical problems which result in acute renal failure. The educational experiences given to the medical students, resident staff and nursing students were considered to be significant additional attributes of such a unit. A valuable service could also be provided to the cases of renal failure throughout the hospital, and in the community.

Only after sufficient personnel had been trained was the unit established. The mere presence of a Skeggs-Leonard hemodialyzer was not enough; well trained and interested persons were considered of much greater importance to the success of the unit. To assure that the residents were adequately experienced prior to their period of responsibility, at least one resident per year since 1955 has spent 6 months to a year in the kidney laboratory of Dr. John P. Merrill at the Peter Bent Brigham Hospital in Boston.

Prior to the first human dialysis in the spring of 1957 many trial dialyses were performed on dogs. Only a few patients were managed during the first year of activity. The indications for hemodialysis were very rigid and in the beginning this procedure was used only as a last resort in the care of patients with renal failure. As the unit began to function more efficiently the criteria for dialysis broadened and more cases were treated.

In 1958, the Kolff twin coil hemodialyzer was purchased and numerous trial dialyses were performed on dogs. Since that time, at least one dialysis per week has been carried out on either a patient in renal failure or a dog, using this equipment. The need for a smoothly operating team is assured by these frequent dialyses. The technical ease experienced with the Kolff kidney has further extended the indications for dialysis. Chronic cases of renal failure were accepted and remarkable remissions were obtained on some of the seemingly hopeless terminal cases of uremia. The unit also became more active with the referral of patients in renal failure from other hospitals throughout the state. The second Kolff hemodialyzer was obtained in 1959 to assure that adequate equipment would be available in the event of technical failure or the need for two dialyses simultaneously. The latter circumstance has, in fact, occurred since the acquisition of the second unit.

We have recently had available the MacNeill-Collins dialyzer to provide a third functioning unit. The valuable features of this equipment include its simplicity, portability, wide margin of safety, and economy. The small blood capacity of this machine eliminates the need for blood priming. A disposable dialyzing unit has recently been developed for this equipment by one of the men in our department. Patients with renal failure secondary to trauma have been noted to require more frequent dialyses in order to prevent complications and to improve the survival rate. The portable MacNeill-Collins kidney would seem to have many advantages for use in such cases, and we are presently evaluating it.

PERSONNEL CONCERNED WITH THE HEMODIALYSIS UNIT

During the second year of the 3 year residency program in urology, each resident is assigned to research activities and to the hemodialysis unit

for a 4 month period. He is responsible for the evaluation of renal failure patients throughout the hospital and for the technical management of the hemodialysis when indicated. The staff men of the urology department, Dr. Weller of the department of internal medicine and the cardiologists of the heart station are available for consultation and advice. Although these men play no active role in the activities of the unit, their experience and advice are great assets. The senior residents, having completed their rotation through this unit, are also available for assistance.

Two technicians, trained in biochemical analysis, are primarily employed in the renal physiology unit to analyze renal function and stone study determinations. It is considered that these interested and well-trained ancillary personnel are very essential to the successful operation of the hemodialysis unit. They are responsible for the ordering of new supplies and equipment and the sterilization of the surgical instruments. While the resident staff rotates from this service every 4 months, these individuals are more permanent and they take great pride in their role as a part of the well-organized team. During the hemodialysis both technicians are present to assist the resident surgeon in assembling the dialyzer and to perform the biochemical studies that are necessary.

A private duty nurse always attends the patient during a dialysis. In addition to reassuring and comforting the patient she is responsible for the accurate recording and reporting of blood pressure and pulse periodically throughout the procedure.

ADVANTAGES OF A HEMODIALYSIS UNIT

Many advantages accrue to the incorporation of a hemodialysis unit in the urology residency training program:

1. It provides residents with a working knowledge of fluid and electrolyte balance in the management of patients with renal failure.

2. In the hospital postgraduate program, the residents travel throughout the state, informing physicians of advances in our field so that the doctors of Michigan become better informed in regard to renal failure and its related problems. The public relations value of these statewide talks has been manifested by a larger number of referred cases.

3. The resident interested in research has an opportunity to pursue problems associated with the functioning of the hemodialyzers.

4. The responsibility for evaluating patients referred to this unit, and the actual technical experience of operating the various types of hemodialyzers provide the resident with knowledge and experience helpful to the well trained urologist of today.

MATERIAL

During 1959, forty-seven patients with renal failure were treated on the urology service. In 24 the diagnosis was acute renal failure; in 23, failure as a result of chronic renal disease. A total of 45 hemodialyses were performed in 30 patients.

METHODS

The therapeutic management of these patients followed essentially the regimen as outlined by Merrill.[1] Patients received a maintenance of 400 cc fluid per day, to which was added a volume equivalent to other measured fluid losses, such as urine output and loss from the gastrointestinal tract. Caloric requirements were prescribed in the form of carbohydrate and fat, and protein was restricted. Determinations of serum electrolytes, urea nitrogen and creatinine were obtained daily. Hyperkalemia was managed satisfactorily with exchange resins administered rectally.

The Kolff disposable, twin coil, artificial kidney was employed for all dialyses.[2] In dialyzing 2 children, a single coil was used, both to reduce the amount of extracorporeal circulating blood volume, and to minimize the hypotension often seen in the initial phase of dialysis. Radial artery to antecubital vein was the most frequently employed circuit, though the saphenous vein was utilized as an arterial source in several instances. Flow rates of 200 cc to 300 cc per minute were considered optimal when a 3 to 6 hour run was carried out. The average dialysis took 4 hours. Ultrafiltration is possible in patients in whom edema is marked; approximately 400 cc ultrafiltrate per hour can be removed in this manner with the Kolff apparatus, and also with

[1] Merrill, J. P.: The Treatment of Renal Failure: Therapeutic Principles in the Management of Acute and Chronic Uremia. New York: Grune and Stratton, 1955.

[2] Kolff, W. J., Watschinger, B. and Vertes, V.: Results in patients treated with coil kidney (disposable dialyzing unit). J.A.M.A., **161:** 1433–1437, 1956.

our recently acquired MacNeill-Collins dialyzer. Regional heparinization was utilized in patients in whom systemic anticoagulation was contraindicated.

Indications for dialysis have not been specifically defined and, in general, our criteria are similar to those described by Kiley: clinical deterioration, as manifested by impaired cerebration; intractable nausea and vomiting, pulmonary edema or severe electrolyte abnormality which has not responded to conservative measures, constitutes candidacy for dialysis.[3]

ACUTE RENAL FAILURE

Twenty-four patients were treated for acute renal failure. In 13 cases the condition was acute tubular necrosis: in six, oliguria resulted from operative or postoperative hypotension; in four, ingestion of ethylene glycol or mercuric chloride was the cause, while in the other 3 patients renal failure followed instances of gunshot trauma, eclampsia and perforated peptic ulcer. Six patients were oliguric because of acute glomerulonephritis and three suffered from renal artery occlusion. There were single cases of renal cortical necrosis and myoglobinuric nephrosclerosis. The latter case is being studied in detail for we believe it may be the only reported example of renal failure resulting from Zenker's hyaline degeneration.

Survival in relation to dialysis, duration of oliguria, age and nitrogen retention. The 19 patients who required dialysis had a survival of 37 per cent; of the seven who survived, one was dialyzed twice, the others once each, while of those patients who died, three were dialyzed once, seven twice, 1 patient required dialysis three times and another was dialyzed on four separate occasions. In the nondialyzed group of patients the survival was 80 per cent and the single death occurred in a patient admitted in terminal condition.

The age of patients requiring dialysis appeared significant in determining prognosis. Of surviving patients who were dialyzed, the average age was 27 years, with the youngest 8 years, the oldest 47 years of age. In patients who died, the average age was 43 years, with the youngest 4.5 months, the oldest 66 years of age. The 4.5 month infant is believed to be the youngest patient to have undergone dialysis in any medical center.

Average predialysis blood urea nitrogen level in patients who survived was 200 mg. per cent and duration of oliguria was 12 days. In patients who died, the average predialysis blood urea nitrogen was 280 mg. per cent and duration of oliguria 14 days. One patient, a 44-year-old man who suffered acute tubular necrosis secondary to ethylene glycol ingestion, survived after 26 days of oliguria and 2 dialyses.

Complications. The dominant role of complications in the clinical course of uremia was re-affirmed in this survey. In 50 per cent of the patients infection of some sort developed during their illness. In 5 patients, the infection was of a major nature, e.g., pneumonia or septicemia, and contributed significantly to clinical morbidity. Two patients died as a direct result of infection. Other complications frequently seen were gastrointestinal bleeding, pulmonary edema, hypertension and anemia.

Discussion. The survival rate of 46 per cent in all cases of acute renal failure, and 37 per cent in those which required dialysis, parallels the experience reported by others.[4, 5] Duration of oliguria does not appear significant in determining prognosis.[3] The pre-dialysis blood urea nitrogen averaged 40 per cent greater in patients who succumbed; previous investigators have not related prognosis to degree of nitrogen retention. Patients who died were found to average 16 years older than those who survived, though the spectrum of distribution was broad in both groups. Prognosis in acute tubular necrosis is related to the setting in which the disease develops. Cases which follow trauma or surgery have a poorer prognosis than those caused by eclampsia or ingestion of toxins. Our survival was 50 per cent and 60 per cent in the two groups; a less significant difference than has been noted by others.[5, 6] Our finding of infection in 50 per cent of the patients was not as great as that reported by Bluemle,[5] and may be due in part to our strict enforcement of isolation precautions.

[3] Kiley, J. E., Powers, S. and Beebe, R.: Acute renal failure. New Eng. J. Med., **262:** 481–486, 1960.

[4] Keleman, W. A. and Kolff, W. J.: Survey of dialyses for acute renal failure at Cleveland Clinic Hospital in 1958. Cleveland Clinic Quart., **26:** 227–234, 1959.

[5] Bluemle, L. W., Webster, G. C. and Elkington, J. R.: Acute tubular necrosis. AMA Arch. Int. Med., **104:** 180–197, 1959.

[6] Bluemle, L. W., Jr.: Acute renal failure. Gen. Pract., **16:** 111, 1957.

The incidence of central nervous system complications and cardiac abnormalities was not of the magnitude described by others.[7]

CHRONIC RENAL FAILURE

Twenty-three patients were treated for chronic renal failure: eight had chronic glomerulonephritis, five had ureteral obstruction, congenital or secondary to neoplasm, four suffered from chronic pyelonephritis while three had polycystic disease. There were single instances of bladder outlet obstruction with hydronephrosis, sclerosing pyelonephritis secondary to retrograde catheter injection of sodium nitrite, and ureterosigmoid anastomosis for exstrophy of the bladder. Thirteen of the patients died in spite of treatment.

Dialysis. Dialysis was performed in 10 cases of chronic renal failure. Several patients received gratifying remission of clinical symptoms or electrolyte abnormalities: one patient is a 21-year-old married woman with bilateral ureterosigmoid anastomosis who at present is in the latter stages of an uncomplicated pregnancy, with no evidence of further deterioration of renal function; another is a 40-year-old man with polycystic disease who received a prolonged remission of symptoms of hypertension.

[7] Swann, R. C. and Merrill, J. P.: Clinical course of acute renal failure. Medicine, **32**: 215–292, 1953.

Discussion. Indications for dialysis in this group of patients are less specifically defined than in acute renal failure. In large part this is a matter of individual philosophy. Patients in whom there exists the possibility of a superimposed acute process, either exacerbation of renal disease, acute infection or surgical disease, are candidates for dialysis.[1] In the latter instance, dialysis may be a valuable preoperative adjunct. Relief of intractable symptoms, such as nausea and vomiting, or recurrent convulsions, is often obtained. The hypertension and symptomatology of polycystic disease are sometimes markedly improved for prolonged periods of time. In centers where renal transplantation is performed, dialysis can be used to optimally prepare the recipient.

SUMMARY

Our experience with the treatment of 45 cases of renal failure is presented. The significance of age, duration of oliguria, nitrogen retention and complications in acute renal failure is discussed. Our interpretation of the role and value of hemodialysis in the management of both acute and chronic renal failure is submitted.

We consider the experience gained in a hemodialysis unit to be a significant asset in our urology training program.

DISCUSSION

DR. REED M. NESBIT (Ann Arbor, Mich.): Two members of my resident staff have told you how it came about that we have a dialysis unit on the urological service at Ann Arbor.

We struggled with the matter for several years. As I traveled around the country, wherever I went I inquired, "How do you make a dialysis unit work?" Most answers were, "We don't have one. We have a dialyzer and nobody wants to run it."

A term that kept coming up was, "Nobody wants to saddle anyone with it." This was particularly emphasized when I inquired of one of my friends at Mt. Sinai Hospital in New York. Even Dr. Kolff didn't want to be saddled with it while he was there. He has since been riding that saddle pretty hard in Cleveland, because that is his full-time job.

I was visiting Rochester, Minnesota one time at a clinical science meeting, and we went through their Science Research Building and saw their dialysis unit in that building. It was working, so I stayed there and pumped a little fellow for about an hour. I asked, "What makes it tick?" The answer was, "It runs well because we have a couple of frustrated doctors who are just high school graduates, who take great pride in running it. The doctors have the know-how, but these people run it." That gave us an idea. They said they do a dialysis on a dog about twice a week, and the machine has to work all the time in order to work successfully.

You have heard the presentation of Dr. William Lakey and Dr. Joseph Cerny. These men organized the work themselves. I had nothing whatever to do with it, and neither did my associate, Dr. Lapides.

Dr. Lakey, one of my senior residents, will go back to Edmonton in July to be professor of urology at the medical school there with Walter MacKenzie.

DR. GERSHOM J. THOMPSON (Rochester, Minn.): I wish to congratulate Dr. Lakey and Dr. Cerny on the very well presented paper they have given. They certainly did very well indeed.

We obtained our first dialysis unit in 1954, and Dr. Frank T. Maher is the man in Rochester to whom we owe the greatest debt for bringing the artificial kidney to the clinic and in improving its use.

Dr. Maher performed 200 dialyses on dogs during the course of a year before he felt inclined to use it on a patient. He found out a lot about dialysis, particularly the occurrence of hypotensive reactions.

At first the dogs died almost uniformly, no matter what type of blood was used to charge the pack. He finally found that 5 per cent human serum albumin was the best liquid to use to charge the pack. It is now used routinely.

(Slide) Dr. Maher and his associates, Dr. James C. Broadbent, Dr. John A. Callahan and Dr. Guy W. Daugherty, are in charge of the operation of this unit at our institution. This is really a modified Skeggs-Leonard hemodialyzer unit, improved by the Mayo Clinic section of engineering. We have two of these units, each equipped with a heparin pump as well as a blood pump. The heparin pump is at the side and the blood pump is up here; this the dialyzer pack, this is a clot and bubble trap. The tank that contains the dialysis fluid can be regulated as to pressure, the hydrostatic pressure in the tank is kept lower than the hydrostatic pressure in the pack, a safety feature so that if there is a weak spot in the cellophane tubing none of the dialyzing fluid will get into the patient.

Dr. Maher prides himself in saying that within 90 minutes after the decision is made to dialyze a patient, the patient can be on the unit. I think that is a very fine record. It involves keeping formaldehyde, 0.4 per cent solution, circulating through this unit at all times. He has two of these in his laboratory. When the decision is made to dialyze a patient the cannula will be placed, and by that time they have washed out the formaldehyde with sterile saline, have charged the pack with 5 per cent human serum albumin and are ready to begin. This serum albumin, as I said, prevents hypotensive reactions, and is a fine thing for that reason.

(Slide) We believe the unit is primarily useful for cases of acute renal failure. Of course, we all know that not all cases of acute renal failure need dialysis because by careful regulation of fluid intake alone, by avoidance of over-hydration, the patient with severe oliguria will survive in the majority of cases.

Of course, this requires weighing the patient daily to make sure that you do not give him too

much fluid, watching particularly for hyperkalemia, controlling it with ion exchange resin enemas, and finally, if necessary, by dialysis.

These are the important things in treating the anuric patients. We feel that the function of the dialysis unit is to borrow time for a recoverable kidney. We do not believe this is a method that will be useful for very long in cases of chronic renal failure. This is primarily a treatment for acute renal failure.

Such a case is shown here of a boy who had spontaneous pneumothorax. An attempt was made to aspirate the air from his pleural cavity. Bleeding was encountered and finally a hemothorax. Finally the chest was opened in order to control the bleeding. Unfortunately he was given 10 units of mismatched blood. This occurred in a hospital far removed from Rochester. The boy went into acute failure, as would be expected.

He was put on the dialyzing unit five different times. You can see charted here diuresis that occurred late in the course of the treatment.

(Slide) This is an electrocardiogram (I don't purport to know all about this) which is abnormal. This is the hyperkalemic effect. This is a normal one here, obtained in about one hour twenty-five minutes after dialysis was started.

(Slide) This shows a case that had lower nephron syndrome after transurethral resection of a tumor. He was dialyzed the third time when he was in the diuretic phase, because he was so toxic at that time; his urea got up to close to 700, and it was not until he was dialyzed the third time that the urea was reduced and he finally made the grade.

(Slide) The last slide is that of a patient who had chronic renal failure, a medical student with acute glomerulonephritis as it finally turned out. He was dialyzed ten times over a course of 51 days of hospital stay.

(Slide) This shows the kidneys which were finally removed at postmortem study. They weighed less than 60 gm.

(Slide) This shows the extensive glomerular involvement, the proliferation of the epithelium of the glomerular tuft, the synechia with attachment to the glomerular capsule, the intertubular fibrosis, the tubules themselves being comparatively normal.

(Slide) The point is that this was not a recoverable kidney. Practically all the glomeruli were found in this condition at postmortem examination. The pathologist was sure that this represented a stage of glomerulonephritis that he had never seen before, that was able to develop in the kidney as a result of prolongation of life by the dialysis unit.

I hope I have made the point that dialysis is particularly useful for acute renal failure which is due to a recoverable renal lesion.

One sees many patients with chronic renal failure whose hopes have been falsely aroused for whom the use of dialysis is tempting. But when the very temporary benefit which might be obtained is weighed against the risk, discomfort and expenditure involved, the only sound advice seems to be not to use the method indiscriminately.

Dr. Alex B. Alder (130 Grey St., East Melbourne E 2, Victoria, Australia): First of all, gentlemen, I would like to thank the Association for having invited me here. There has been a wealth of knowledge learned, and I have enjoyed every second of it.

Secondly, I have a message from Dr. Meredith Campbell for the Association. I had lunch with him the day before yesterday in Miami. He extends his best wishes. He is not well and so could not attend.

As regards the dialyzer, we have one in Melbourne. There is one case I would like to report, a boy of 13 who had a single kidney with a pelviureteric junction obstruction. His blood urea was 200 mg. per cent preoperatively and he was sinking fairly rapidly. We resuscitated him as well as we could and then operated.

He had a "Culp" pyeloplasty. All went well for the first 3 days, until on the third day he started to bleed profusely from his nephrostomy tube. In spite of a lot of transfusions and what we felt was good postoperative work, petechial hemorrhages developed and the patient sank fast. Then he became oliguric in spite of our washing the clot out of his renal pelvis. We found he had a prothrombin 10 per cent of normal, and he did not secrete any urine for several days.

We connected him up to the machine and within a week he was walking about the ward, passing normal quantities of urine. His nephrostomy tube was removed and he is now well. This happened about six months ago.

In retrospect, I feel that the use of the dialyzer for this type of case should be done preoperatively, but it has a great use for the single kidney on which pyeloplasty is done.

DR. HARRY M. SPENCE (Dallas, Texas): I would like to ask Dr. Goodwin a question. Apart from these three cases of ureteral substitution for stone, in the other cases where he has used ileum as a ureteral substitute has he had any electrolyte problems?

DR. FRANK HINMAN, JR. (San Francisco, Cal.): I would like to hear a discussion of the relative value of peritoneal dialysis versus the use of the artificial kidney, since there is a tendency in this country to move back to that method.

DR. CLARENCE V. HODGES (Portland, Ore.): I would like to make one comment in regard to what I think is an indirect bonus resulting from having a renal dialysis unit in our institution.

I think many more lives have been saved than the number of patients who have been dialyzed, because with the knowledge and refinement of management leading up to dialysis, there has been a tightening—a real improvement—in the management that was stressed by the essayists. This has carried many patients safely through a period of renal shutdown when otherwise they would have been overloaded and would have been lost.

I want to make some specific comments regarding improvements that we have found in our experience of four years with renal dialysis.

One is the treatment of hyperkalemia by dialysis through a resin column tube. This will be reported at the American College of Surgeons. Essentially a sodium cycle resin column is used and blood is pumped through this with the Sigma pump.

Second, the use of the McIntosh tube permits a single femoral vein catheterization. It takes about half the time of two vessel cannulations. It is a two-lumen tube that extends up into the inferior vena cava. The lumens exit at separate points, so there is about a 30 cm. column of blood in the inferior vena cava between the two. One is the outflow and the other is the inflow. We have had no problems with thrombosis or other venous complications.

Recognition of the value of earlier dialysis had been part of the work of Scribner; we feel that patients should be dialyzed before they become terminal.

This is an excellent paper; I have enjoyed it greatly.

DR. JOHN F. PATTON (Washington, D. C.): I would like to ask if an indwelling urethral catheter is used during the period of oliguria or inserted during dialysis.

DR. WILLIAM LAKEY (% Dr. Reed M. Nesbit, Ann Arbor, Mich.): If possible, we prefer to avoid using urethral catheter drainage in our renal failure patients. In the case of comatose patients, however, catheter drainage is a necessity in order to follow the urinary output.

DR. GERSHOM THOMPSON (Rochester, N. Y.): May I comment on Dr. Hinman's question.

Our men feel that there is no comparison whatever between the effect of peritoneal dialysis or lavage and the use of this machine. They feel that the machine is far superior.

May I mention a figure? We have done now 103 dialyses on 54 patients. Not long ago a comparison was made as to the value of single dialysis against multiple dialyses. In these particular two groups there were 35 patients, 20 who had single dialysis, 10 of whom survived. Fifteen had multiple dialyses and nine survived. That is an improvement from 50 to 60 per cent. These were almost all cases of acute renal failure.

DR. J. HARTWELL HARRISON (Boston, Mass.): Gentlemen, I would just like to emphasize the credit that should go to Dr. Reed Nesbit for setting up and developing such a program in Michigan. I am sure we need more such programs elsewhere.

I admire his fortitude and energy in doing it all on the urologic services. We have it easier at the Brigham. It is primarily on the medical service. John Merrill has been a friend to all of us because of what he has done, not just with reference to the artificial kidney but with regard to the management of renal insufficiency.

Peritoneal dialysis we use seldom. We use it when external dialysis is contraindicated. It is not as effective, as Dr. Thompson said, but there are occasions when you cannot use external dialysis, and then peritoneal dialysis is useful. We have used it in extreme barbiturate poisoning.

DR. ROBERT S. HOTCHKISS (New York, N. Y.): We also have a dialysis unit at Bellevue, operated entirely by urologists.

In answer to the question about peritoneal dialysis, we have used peritoneal dialysis for the treatment of uremia in children on many occasions. The irrigating fluids may be used continuously for four to six days. Peritonitis has not been a complication.

DR. REED M. NESBIT (Ann Arbor, Mich.):

I would like to make two comments. I want to express publicly the debt of gratitude I owe to Dr. Hartwell Harrison for taking on this group of young men at the Brigham.

Second, I admire and envy the sophistication and knowledge that my resident staff have acquired in this particular area, because they are using this tool. One of the greatest benefits that I see is the sophistication and knowledge in renal physiology that our medical students are now acquiring from these young gentlemen. It is a matter of great pride to me.

Dr. Willard Goodwin (Los Angeles, Cal.): In answer to Dr. Spence's question about other patients with ileal ureters and electrolyte problems: you may recall when I talked about this before, I mentioned one patient who had become gravely ill with electrolyte problems. This patient was one with a solitary kidney, who was uremic when we started.

We learned from that the bitter lesson, never to use an ileal ureter in a patient who is already uremic. However, if the patient has normal blood chemistry values we haven't had trouble. The boy with the solitary kidney has lived 3 years now and has remained perfectly normal, with all of his urine going through the ileal ureter. The patient with the solitary kidney and papillary tumor of the ureter had a ureterectomy and establishment of an ileal ureter. He has lived for 2 years without significant changes in his electrolytes.

Dr. Hinman pointed out to me that I had not made it clear that this is a mucosa-to-mucosa anastomosis. It has to be pelvic mucosa-to-mucosa and all layers of the ileum.

RETROPERITONEAL FIBROSIS PRODUCING URETERAL OBSTRUCTION

DONALD A. CHARNOCK, HERMAN I. RIDDELL AND LOUIS J. LOMBARDO, JR.

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When Ormond described in 1948 a syndrome of progressive fibrosis, which engulfed the ureters leading to compression and eventual anuria, he professed that the process, while new to him and to his pathology department, could not be limited to the two cases which had come under his observation.[1] His communication initiated a chain reaction which has produced an increasing number of papers dealing with this hitherto unknown, or perhaps unrecognized, process. Ormond assigned no designation to this syndrome, and a variety of descriptive terms have been applied by various authors mainly describing the location of the obstruction. Out of these reports is emerging some evidence which may be used as common denominators in the understanding of this unusual disease.

In the earlier descriptions the fibrotic enveloping process was limited to the mid lumbar area roughly encompassing L3 to L5. Subsequent papers have recorded involvement of the perirenal area.[2, 3] The fibrosis may extend over the pelvic brim[3] and a recent article describes encasement of the bladder neck, trigone, and distal aspects of both ureters.[4]

Variations in the type of involvement have been reported. The most frequent lesion appears as a flat, firm, greyish-white fibrous mass which is usually found in the midline and extends laterally compressing one or both ureters (figs. 1 and 2). The process does not invade the ureters, the aorta, or the vena cava, but engulfs them.[5]

A less common variation was first described by Vest and Barelare[6] and later by others[7-10] in which one or both ureters are encased by a dense fibrous sheath which extends along the ureters for a variable length. On cross-section the ureter is compressed, but does not appear to be invaded. The process is limited to the ureter and does not extend to or across the midline. Histopathologically there seems to be no significant difference between these two variants.[6]

A possible third variety of involvement is illustrated by the case reported by Coppridge and his associates[11] in which the histopathology showed a preponderance of disruption and necrosing of the fat cells intermingled with the fibrotic process. This steatitis reaction has been described in many of the micropathological descriptions.

From these reports it seems evident that no part of the urinary tract is immune to this invasion, and that variations in the type of obstruction may be expected. While several authors, especially Hutch and his group,[12] have classified these variations as separate entities, Hawk and Hazard (themselves pathologists)[5] are inclined to group them as variants of a single disease process.

The onset of this disease is insidious and the presenting symptoms often seem unrelated to

[1] Ormond, J. K.: Bilateral ureteral obstruction due to envelopment and compression by an inflammatory retroperitoneal process. J. Urol., **59:** 1072–1079, 1948.

[2] Paul, D. P., Causey, J. C. and Hodges, C. V.: Perinephritis plastica. J. Urol., **73:** 212–216, 1955.

[3] Raper, F. P.: Idiopathic retroperitoneal fibrosis involving ureters. Brit. J. Urol., **28:** 436–446, 1956.

[4] Hewett, A. L. and Headstream, J. W.: Pericystitic plastica. J. Urol., **83:** 103–107, 1960.

[5] Hawk, W. A. and Hazard, J. B.: Sclerosing retroperitonitis and sclerosing mediastinitis. Am. J. Clin. Path., **32:** 321–334, 1959.

[6] Vest, S. A. and Barelare, B., Jr.: Periureteritis plastica: A report of 4 cases. J. Urol., **70:** 38–50, 1953.

[7] Houston, W.: Periureteritis plastica: A report of a case, with indications of a probable pathology. Brit. J. Urol., **29:** 38–41, 1957.

[8] McDonald, S. A. and deDomenico, I. J.: Periureteral fibrosis. Canad. J. Surg., **1:** 162–166, 1958.

[9] Mulvaney, W. P.: Periureteritis obliterans: A retroperitoneal inflammatory disease. J. Urol., **79:** 410–417, 1958.

[10] Oppenheimer, G. D., Narins, L. and Simon, N.: Radiotherapy in treatment of nonspecific inflammatory stricture of ureter. J. Urol., **67:** 476–478, 1952.

[11] Coppridge, W. M., Roberts, L. C. and Hughes, J.: Sclerosing lipogranuloma. South. Med. J., **48:** 827–833, 1955.

[12] Hutch, J. A., Atkinson, R. C. and Loquvam, G. S.: Perirenal (Gerota's) fascitis. J. Urol., **81:** 76–95, 1959.

FIG. 1. Bilateral involvement. Note medial displacement of ureters pulled in by fibrous plaque

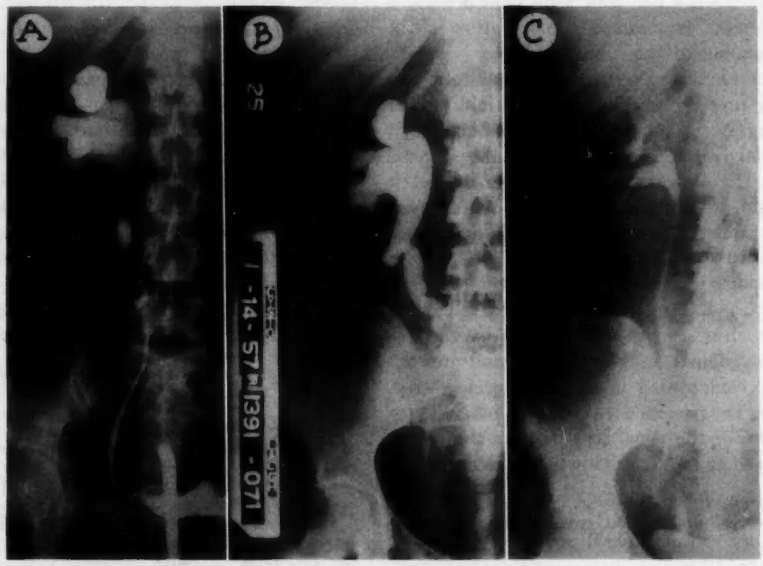

FIG. 2. Unilateral involvement. *A*, retrograde study shows extrinsic ureteral obstruction. *B*, trapped medium above point of obstruction. *C*, postoperative result with ureter in lateral position and obstruction relieved.

urinary tract disease unless oliguria or frank anuria is present. Vague backache and flank pain frequently result in numerous examinations before intravenous urograms arouse sufficiently the index of suspicion to institute more comprehensive urologic studies. The majority of these patients fall in the mid age group. The youngest reported case was 23, the oldest 69. Men predominate over women in the ratio of 2 to 1. In the pre-anuric phase the urinary

symptoms are practically nonexistant. In general, the physical and laboratory examinations give little lead in the understanding of the problem. The nitrogen retention levels reflect the degree of urinary obstruction. With the onset of oliguria or anuria, which was a presenting symptom in several of the cases, attention is focused directly upon the urinary tract. Here the physician must determine the cause for the anuria and differentiate between the various types of urinary shutdown.

The introduction of ureteral catheters gives important information. The catheter is usually advanced with difficulty but rarely meets a true obstruction. As has been pointed out by Hutch, Atkinson, and Loquvam[12] this is to be expected where the ureter is compressed but not occluded. The flat film with catheters in place frequently shows a medial displacement of the ureters which has been found in many of these cases. The pyelograms will indicate the degree of obstruction and the pyeloureterograms will outline the extent of the ureteral compression. Injection of the ureter with a cone tip catheter may prove an advantageous method for outlining the ureter, especially where catheters cannot be advanced beyond the obstructive lesion. While urographic aids will give valuable leads, surgical exploration is, at this time, the only means of definitive diagnosis.

Retroperitoneal fibrosis must be differentiated from malignant infiltration such as Hodgkin's disease, lymphosarcoma, reticulum cell sarcoma, fibrosarcoma, and metastatic carcinoma as well as neoplasms of the kidney and ureter. Inflammatory lesions such as syphilis and tuberculosis must be considered.

The treatment for retroperitoneal fibrosis depends upon the degree of urinary obstruction. In the anuric phase re-establishment of drainage is mandatory. If ureteral catheters can be introduced the immediate emergency may be overcome. The experience of others has shown that failure of catheters to drain adequately, or their removal, results in an immediate return of the anuria. As has been pointed out by Hutch, Atkinson, and Loquvam,[12] "those patients in whom nephrostomy drainage was instituted early did the best. Certainly with one or both nephrostomy tubes in place, the surgeon is in command of the situation, and can plan his attack on the trapped ureters as he chooses."

Definitive lysis of the ureters may be best accomplished, in our opinion, by a transperitoneal approach. The majority of the cases reported have bilateral involvement. In this manner both ureters may be visualized, the obstructing plaque more carefully outlined and adequate biopsy material obtained. Actual freeing of the ureters varies according to the degree of involvement. In our experience this has not been difficult, but several reports indicate that resection and end to end anastomosis have been found necessary. The point of major constriction is often at the area of the sacral promontory where the ureter crosses the iliac vessels. Dissection at this level must be carried out with caution. Once the ureter has been freed from the plaque some attempt should be made to guard against further encroachment. No rule can be laid down for each case presents its own problem. As Raper[3] has so nicely expressed it, the ureter should be "stitched out of harm's way." Unfortunately, there is no guarantee that these ureters once freed will return to normal function. Neither can we assume that the fibrotic plaque is a self limited process. Reports by Iozzi and Murphy[13] and Mirabile and Spillane[14] indicate that the fibrosis continues to advance. It is interesting here to speculate upon the role of the perirenal fascia in the growth of the process. If it tends to grow in this closed compartment then opening of this space and removal of its fat may prove of advantage in containing the progress of the fibrosis.[12] In any event, until we are able to completely extirpate the plaque or to effectively control its progress by adjuvant therapy these patients must be followed indefinitely.

Adjuvant therapy has not been widely used. On the basis of the inflammatory nature of the lesion, antibiotics have been used with equivocal results. X-radiation has been reported in 4 cases.[1, 10, 15, 16] Corticosteroids have recently been employed. Certainly this form of therapy merits further exploration.[5, 15]

[13] Iozzi, L. and Murphy, J. J.: Bilateral ureteral obstruction by retroperitoneal inflammation. J. Urol., **77:** 402–406, 1957.

[14] Mirabile, C. S. and Spillane, R. J.: Bilateral ureteral compression with obstruction from a nonspecific retroperitoneal inflammatory process: Case report. J. Urol., **73:** 783–787, 1955.

[15] Schifrin, A., Oppenheimer, G. D. and Krawitt, D. R.: Idiopathic nonspecific fibrosing retroperitonitis causing bilateral ureteral compression. J. Mt. Sinai Hosp., **24:** 1186–1199, 1957.

[16] Bradfield, E. O.: Bilateral ureteral obstruction due to envelopment and compression by an inflammatory retroperitoneal process. J. Urol., **69:** 769–773, 1953.

CASE REPORTS

We submit 5 cases for addition to the increasing group of obstructing fibrosis.

Case 1. HGS No. 59-6489. A 63-year-old white man was well until March 1959 when pain developed in the right lower quadrant. He had no urinary symptoms. The past history was noncontributary. The laboratory findings and x-rays of the chest, gallbladder, and the entire bowel were all within normal limits. Aside from slight tenderness to palpation in the right lower quadrant, the physical examination was negative. The pain persisted, but did not radiate. At this point excretory urograms revealed a normal left upper tract but no function on the right side. On cystoscopy a catheter was passed fairly easily to the right pelvis. There was grade 2 hydronephrosis with a fusiform narrowing of the ureter opposite L2 and L3. The ureteropelvic junction and the ureter distal to the obstruction were normal in caliber. In the delayed films the dye was retained in the pelvis and upper ureter. The erect film showed no descent of the kidney.

Through a right subcostal incision exploration was carried out both extra- and intraperitoneally. A hard, fixed mass was found retroperitoneally the size of the palm of one's hand. It lay posterior to the duodenum and pancreas and completely enveloped the aorta and vena cava. It encased the right ureter for a distance of 4 to 5 cm. It extended toward the left side but did not involve the left ureter or kidney. It looked and felt like malignant infiltration, yet frozen sections showed only benign fibrosis. Ample biopsies were taken. The right ureter was freed from the mass. The micropathological report was consistent with a diagnosis of retroperitoneal fibrosis. Bacteriological studies for tuberculosis and fungi were reported negative. The patient has made a good recovery. He remains asymptomatic, and repeated excretory urograms show fairly normal renal function to the present time.

Case 2. HGS No. 59-14833. This man has been periodically under our care since 1954 when his complaint was urinary difficulty with occasional pain in the right flank. He was decidedly overweight. An upper tract study was advised which was done in 1955. A low median bar was found. Retrograde pyelograms revealed normal pelvicalyceal silhouettes on both sides. In 1959 extensive furunculosis developed for which the patient received extensive antibiotic therapy. In August 1959 he re-entered the hospital because of weight loss and anorexia. At this time he was drowsy. The nonprotein nitrogen was found to be 133 mg. per cent and the Co_2 2 meq. On the day of admission the urinary output was 40 cc. On active hydration the output increased and the nonprotein nitrogen dropped slowly to normal. Marked anemia required repeated transfusions. Excretory urograms showed bilateral hydronephrosis with ureters dilated to the brim of the pelvis. A cystoscopy with cone tip injection revealed narrowing of both ureters by extrinsic pressure in the region of the pelvic brim. Delayed drainage was demonstrated from both sides.

On December 31, 1959 an exploration was done through a left paramedian incision. There was an extensive retroperitoneal plaque extending from the level of the renal vessels downward extending across the pelvic brim into the true pelvis and almost to the level of the prostate. The terminal ileum was adherent to the mass. The ureters were encased from well above the pelvic brim down into the true pelvis. All the great vessels were involved in the process. A small aneurysm was found at the bifurcation of the aorta. The terminal ileum was mobilized and both ureters were dissected from the mass. Numerous biopsies were obtained. Micropathological slides showed tissue consistent with retroperitoneal fibrosis and extensive bacteriological studies were reported negative. Intravenous urograms done before discharge showed delayed excretion. The patient, however, has improved clinically. The pain and gastrointestinal symptoms have been relieved, and the nonprotein nitrogen is normal. His blood picture has vastly improved. He is being continued on 5 mg. meticorten 3 times daily.

Case 3. HGS No. 57-2360. A 63-year-old white man was admitted to the hospital with the complaint of backache radiating into the abdomen and inguinal regions. The nonprotein nitrogen was 78 mg. per 100 cc. Excretory urograms showed no clearance on the right side with delayed function on the left. Retrograde pyelograms revealed bilateral hydronephrosis with obstruction 5 cm. distal to the ureteropelvic junction on both sides. Medial deviation of the ureters was not present. Indigo carmine collected through catheters appeared in poor concentration from the left side. None appeared from the right side. Under anesthesia a pulsating mass could be

felt in the midabdomen. The general physical examination and radiological survey were normal. Vascular studies indicated an abdominal aneurysm.

At surgery a large plaque was found extending from the area of the renal vessels to the level of the common iliac arteries. It engulfed the ureters and the great vessels. Within the plaque the aortic aneurysm could be seen. The ureters were dissected free from the mass. By very careful dissection the vena cava was freed. The aorta was resected together with the entire plaque. The segment of aorta was replaced with an arterial homograph. Micropathological studies were overshadowed by the large aneurysm, but a careful review proved the plaque to be consistent with retroperitoneal fibrosis.

The patient made a satisfactory recovery. The nonprotein nitrogen dropped to 34. Excretory function returned on the left side, but the right side showed very poor visualization. By retrograde study the hydronephrosis was relieved. The patient was asymptomatic and returned to full employment.

Eighteen months following the original surgery acute gastrointestinal hemorrhage developed for which immediate surgical exploration was done. Bleeding was due to leakage from the upper margin of the homograft. This was quickly repaired. An exploration of the abdomen demonstrated complete absence of the fibrous plaque with no evidence of reformation. Unfortunately, the patient died from a postoperative accident completely unrelated to his pathological condition.

Case 4. LAGH No. 1B91-0T1. A 33-year-old white woman was admitted to the hospital with an history of recent right salpingo-oophorectomy for a tubo-ovarian abscess, and a bowel resection for diverticulitis. On admission a marked delay in the function of the right kidney was demonstrated with hydronephrosis on this side. Ureterograms showed evidence of extrinsic pressure at the level of the middle third of the right ureter.

At surgery the right ureter was found encased in a dense fibrous plaque extending medially to the aorta. Ureterolysis was accomplished.

Periodic excretory urograms have recorded progressive resolution of the right drainage system.

Case 5. LAGH No. 467-939. A 51-year-old Mexican man was admitted with dysuria and pain in both flanks. Retrograde pyelograms revealed bilateral hydronephrosis with dilatation of the upper ureters. Indigo carmine failed to clear from the right side, and appeared in poor concentration on the left side. The ureters showed medial deviation. Aside from bilateral costovertebral tenderness the physical survey was normal. There was pyuria with E. coli on culture. The nonprotein nitrogen was 56 mg. per 100 cc.

On antibiotic therapy, the flank tenderness persisted. The nonprotein nitrogen rose to 86 mg. per cent. Indwelling catheters were placed for drainage.

A month later a right nephrostomy was done. Four centimeters below the pelvis the ureter was found encased in dense fibrous tissue for a distance of 3 cm. It was dissected from this mass. Six weeks later a left nephrostomy was done. The left ureter was never identified, but remained encased in a dense fibrous mass. The patient was discharged with a nonprotein nitrogen of 56 mg. per cent and with the erroneous diagnosis of ureteral strictures the ureters were periodically dilated.

Four years later, September 21, 1959, this patient, then 57, suffered acute myocardial infarction. At that time the blood urea nitrogen was 37 mg. per cent. He recovered satisfactorily.

On May 5, 1960 the patient had a second infarction, and succumbed. Postmortem study showed an extensive plaque of retroperitoneal fibrosis which extended from above the renal vessels to the pelvic brim. This tissue was consistent with retroperitoneal fibrosis.

DISCUSSION

The incidence of recognition of retroperitoneal fibrosis is increasing. The history and clinical symptoms are far from clear cut but when excretory urograms show delayed function, or when oliguria presents, retrograde pyeloureterograms or cone tip injections of the ureters (fig. 3) will usually outline the area of extrinsic obstruction. We believe that medial deviation of the ureters is a suggestive finding. Surgical exploration is still the only definitive means of establishing the diagnosis. In our opinion, a transabdominal approach offers the superior exposure. Careful lysis of the ureters should be carried out. Periodic followup with repeated excretory urograms is mandatory. The adjuvant use of corticosteroids should be evaluated. While at the present time

FIG. 3. Cone tip injection illustrates extrinsic obstruction in lower third of ureter.

the resection of the great vessels with their replacement with grafts is still a formidable procedure it may be possible in the not too distant future to recommend this as a means of complete removal of the fibrous plaque.

There appears to be a remarkable similarity, on a morphological basis, between retroperitoneal fibrosis and the following clinical entities of obscure etiology: 1) Weber-Christian disease, including the systemic variants; 2) the isolated nodular mesenteric and omental steatitis, 3) sclerosing mediastinitis, and 4) sclerosing lipogranuloma.

In the aforementioned clinical entities the structural alterations in space-time dimensions seem to suggest the following evolutionary phases (fig. 4): 1) multifocal alteration of fat cells at the periphery of the fat lobules, possibly secondary to small blood vessel pathology; 2)

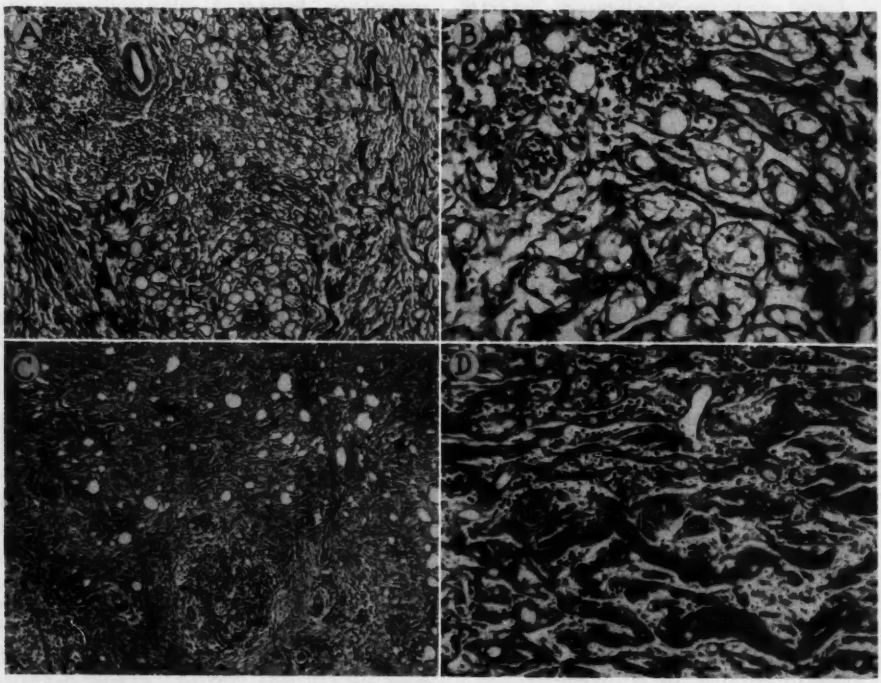

FIG. 4. *A*, atrophy, degeneration and frank necrosis of fat cells with associated inflammatory cellular infiltration. *B*, gradual replacement of degenerated fat cells with active fibrosis beginning at periphery of fat lobules. *C*, coalescence of process with marked replacement of fat lobules. *D*, end stage with marked replacement of fat lobules by richly collagenous fibrous connective tissue with moderate vascularity and usually with mild perivascular infiltration of inflammatory cells.

atrophy, degeneration and frank necrosis of fat cells with associated inflammatory cellular infiltration, 3) gradual replacement of the degenerated fat cells with active fibrosis beginning at the periphery of the fat lobules, 4) coalescence of the process with marked replacement of large groups of fat lobules, and 5) the end stage in which this slowly progressive and perhaps self limited process is that of a marked replacement of fat lobules by richly collagenous fibrous connective tissue with moderate vascularity and usually with mild perivascular infiltration of inflammatory cells.[17]

To the most important question, what, why, and how is this process initiated? Why is it usually limited to a particular anatomic region? Why does the process seemingly slow down and perhaps even stop? The answers are in want.

We wish to express our thanks to J. Howard Payne, M.D. and the late J. Freeman Crane, M.D. for permission and encouragement to use case 3 (H.G.S. No. 57-2360).

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[17] Bangle, R., Jr.: Personal communication.

DISCUSSION

DR. JOHN K. ORMOND (Pontiac, Mich.): I naturally feel a rather proprietary or paternal interest in this condition, since I apparently described the first cases that were ever reported. I have gone over the literature again in recent months because I am scheduled to read a paper on this subject in another month before the American Medical Association, and I am very glad to have heard this fine presentation by Dr. Charnock. I wish I had had a chance to have read it completely before now.

In going over the literature I have found, including Dr. Charnock's cases, 93 cases. There are probably more, because I found some titles in the Russian literature (but I don't read Russian) and some in journals in Italian and Spanish that were not at my disposal. There are a great many reported in the European literature and in our own.

I do not believe this is primarily a urological condition, although it manifests itself in the urological field, and I think it will continue to manifest itself in the urological field. It is impossible to say what the cause of this condition is, but it seems to be an inflammatory condition with fibrous or scar tissue following it that spreads and is nearly always limited by the Gerota's fascia.

There are certain symptoms that seem to appear even before any symptoms from the urinary tract. There is pain from the flanks running down to the inguinal region and to the inner surface of the thighs. Nausea and vomiting are others. Weight loss is another. These occur even before there are any symptoms from the urinary tract and any infection in the urinary tract.

In a great many of these cases there is no infection of the urinary tract even after the condition is full-blown and has involved the ureters. In most cases the ureters, while enveloped, are not involved in the inflammatory process, and can easily be dissected out. I would agree entirely with Dr. Charnock on the fact that in treatment the abdominal route is preferable because you can treat both ureters at the same time then. If you go into the flanks you have to operate on them separately.

As far as diagnosis is concerned, I would like to ask the whole group if they have ever seen the use of presacral carbon dioxide insufflation in diagnosing this condition. It seems to me it would be a rather good procedure in cases of doubt. I have never tried it. I understand it is perfectly harmless.

In going over these 91 cases I have discarded about twenty-one of them as not being true idiopathic cases. There are a certain number that were evidently direct extensions of inflammation of the bowel, ileitis, appendicitis, diverticulitis, and some, like those of Vest, which apparently came directly from the urinary tract.

It is important to discard this diagnosis except as a tentative diagnosis in every patient in whom there has been within a reasonable time (I would say 3 years is a reasonable time) some malignant disease. We were fooled on that this year, and our faces were very red. We had a patient treated for this condition, bilateral nephrostomy, and he died. At autopsy we found he had an undiscovered carcinoma of the prostate, of all things, that involved the ureters. We made many rectal examinations and were unable to diagnose it.

I would like to read a quotation from an editorial in the LANCET of about a year or so ago. "Many a clinical reputation lies behind the peritoneum. In this hinterland of straggling mesenchyme with its vascular nervous plexuses, its wierd embryonic rests, its shadowy boundaries, the clinician is often left with only his plan and his diagnostic first principles to aid him. Nonspecific periureteric fibrosis is likely to tax them both. At an early stage the symptoms usually point to a growing retroperitoneal lesion, but this limited diagnosis is rarely made. Retroperitoneal pain can be severe and persistent enough to drive the most phlegmatic patient to distraction, and when there are no abnormal findings his complaint is likely to be received with incredulity."

I wonder if some of these patients who come in with vague abdominal distress—and sometimes more than vague abdominal distress—with pains running down into their legs—may not have this condition.

DR. JOSEPH H. KIEFER (Chicago, Ill.): I saw my first case of this just about a month ago. The patient did have a urologic symptom although

not related to urination. The patient was a 63-year-old white man. The complaints are only lower abdominal discomfort and scrotal edema. His sac was a little larger than normal, and that was all.

There was a minimal amount of swelling of the lower scrotum. It was not related to activity or anything else. There was a rather doughy feel of the lower part of his abdomen. There was no discernible mass palpable. The x-rays showed only bilateral slight hydronephrosis.

Anterior transabdominal exploration was done. The plaque extended from the lumbar area down into the sacral area on both sides. A general surgeon operated with us; we took a biopsy. The pathologist and surgeon insisted it could be lymphoma. We freed up one ureter (the left) and I didn't have the courage to insist on doing the other one on the basis of the frozen section report of probable lymphoma.

Finally when they got the paraffin sections they said, yes, it was fibrosis. X-rays 2 weeks postoperatively show the freed ureter little different from the other one. He is now on steroid therapy and we will see what happens.

Dr. Willard Goodwin (Los Angeles, Cal.): I should like to show two slides of what I think is the youngest patient with this condition. Dr. John Fairer, now resident urologist at U.C.L.A., discovered an 8-year old girl with retroperitoneal fibrosis when he was working at the L.A. County Harbor General Hospital in Torrance.

(Slide) This shows the pyelogram. You see the hydronephrosis and the tilting of the spine to the left.

(Slide) This is the postoperative film after it was treated by removing the ureter from its retroperitoneal cuirasse.

Dr. Luis A. Sanjurjo (Santurce, Puerto Rico): This patient was referred to us from St. Tomas on account of prostatic obstruction. He had an enlarged gland, grade 2 and we decided to do a prostatectomy suprapubically. When we tried to approach the bladder we found a tremendous amount of fat and fibrous tissue, and one could hardly reach the bladder.

To our amazement, when we opened the bladder there was practically no prostatic tissue to be removed. We found a huge mass of fibrous fatty tissue extending from both kidneys down the ureters into the posterior aspect of the bladder, surrounding the bladder and iliac vessels. We did a biopsy and it corroborated our impression of the tissue being fibrosis.

We tried to liberate both ureters, but all we could do was to strip the fibrous mass down to the ureters. Bleeding was profuse, oozing was marked, and so we just closed him and let him go. That was in 1956.

The patient is doing very well. His symptoms of prostatic obstruction disappeared, his blood chemistry values are normal, and feels so well that he has refused even an intravenous pyelogram.

Dr. Raul Lopez Engelking (Mexico City 4, D. F., Mexico): The only case in my experience on this subject was presented by myself at the South Central Section meeting in Dallas in October of 1958. This was a typical case of the disease in a female 59 years old with recurrent chills and fever and alternate periods of pain in both lumbar areas and both flanks.

When we saw the patient at the County General Hospital she had nausea and vomiting, oliguria and in a few days complete anuria. The medical men could not figure out the cause of the anuria, much less since the anuria disappeared on three occasions after administration of glucose solutions. The patient had very poor general health, a severe toxic condition, high blood urea and more recurrent periods of anuria; then we explored her. We could not pass a catheter through the ureters, but we did obtain a specimen of urine from the bladder for culture which showed Proteus and Pseudomonas. After several attempts to catheterize the ureters, we did a right nephrostomy and found typical plastic ureteritis. The fibrosis was found up to the pelvis of the kidney and down to the bladder. At the same time of ureterolysis, we took a biopsy from one of the multiple plaques with cystic appearance which were all the way of the ureter, and with hard fibrotic consistence. The pathological report was "chronic inflammatory fibrosis and multiple cystic areas."

Thanks to the right nephrostomy, careful ureterolysis, treatment with corticosteroids and adequate antibiotics, it was possible several weeks later to make a dilation of the left ureter even though several attempts had been made before. Frequent dilatations of the ureters were done.

This case is different from those that have been previously reported in the literature because a

combination of the pelvic condition, fibrosis of both ureters and multiple cysts of both ureters and kidney pelvis, seen by retrograde pyelograms, and found on the right ureter during surgery. The biopsy made on one of the fibrotic cysts represented, later on, a problem; a fistula resulted that lasted for several months, even though the patient had normal urograms and pyelograms. We considered that the inelastic and fibrotic ureteral wall maintained the fistula.

Dr. Frank C. Hamm (Brooklyn, N. Y.): I would like to say just a word about the possible association of regional enteritis as an important etiologic factor—certainly not in all cases, but I think it can be important in some.

Instead of being eliminated, as Dr. Ormond has suggested, as an etiologic factor, I would like to propose for your consideration that it be included perhaps to a greater extent than it has been in the past.

The evidence behind my statement is that the first case of plaque that we discovered was at the VA Hospital at Fort Hamilton, and it was associated with obvious regional enteritis. This man had multiple small bowel fistulas to his abdomen. In exploring him we found a lesion or plaque identical with that described.

I want to point out also that in several other patients whom we studied at that time, which cases we reported about ten years ago, we did find evidence of regional enteritis. Regional enteritis may not be an easy thing to diagnose. It is an obscure, inflammatory condition and sometimes is extremely difficult to detect.

I noticed in one of the patients described here that the ileum was attached to the retroperitoneal plaque suggesting the possibility of an inflammatory condition in the ileum as an etiologic factor.

Dr. Ben D. Massey (Pasadena, Cal.): I can't be too specific about the number of cases we have had. I think we have had approximately four. We have been consulted because of ureteral obstruction, to one or both sides. One of our problems has been obtaining proper pathologic diagnosis. In two of the patients, one explored by a general surgeon and one by myself, biopsies were reported as inflammatory. Both patients died later of lymphoma.

Dr. William J. Engel (Cleveland, Ohio): I think this is an extremely important subject and I would not like to leave it without reporting an experience which may have considerable significance and goes along with the remarks made by Dr. Kiefer.

About three years ago we saw a middle aged gentleman who came to our medical department with nonspecific complaints which included weakness, lack of usual energy, loss of appetite and a vague sense of abdominal pressure. An intravenous urogram was done as part of a complete examination. It showed no excretion of contrast medium from the right kidney and hydronephrosis on the left.

A retrograde pyelogram was done on the right side. No obstruction was encountered in passing a ureteral catheter. The pyelogram showed hydronephrosis with marked tortuosity of the upper ureter. The evidence seemed to favor retroperitoneal metastatic disease causing ureteral obstruction and accordingly he was explored by the general surgeon. At least two or three experienced hands palpated within the abdomen and though no primary tumor was found all believed the hard, irregular retroperitoneal mass was some type of malignant tumor even though frozen sections of tissue removed could not supply a certain definitive diagnosis. Several pieces of tissue were removed for permanent histological sections. Nothing more was done and the abdomen was closed. Subsequent study of the biopsy by our pathologist Dr. Hazard reported the diagnosis of sclerosing retroperitonitis.

There being no evidence of renal failure, it was decided to place the patient on steroid therapy. The decision was based upon the favorable response observed in an earlier patient with this disease, who had bilateral ureteral obstruction requiring emergency nephrostomy because of anuria.

The patient was first given ACTH and was later given meticorten. His improvement was quite rapid. A urogram made 5 weeks after starting therapy showed good excretion of the dye from both kidneys and a followup urogram 6 months later was reported to be entirely negative. We have since seen other cases with favorable response to steroid therapy. Operation is, of course, necessary to establish a definite diagnosis, but it would appear that extensive ureterolysis and other surgical procedures may not be necessary in all cases.

DR. DONALD A. CHARNOCK (Los Angeles, Cal.): I realize that coming to the Detroit area to talk about retroperitoneal fibrosis is certainly bringing coals to Newcastle, but it seems that the people in Newcastle are still interested in coals.

As far as presacral carbon dioxide is concerned, it has been used, Dr. Ormond, in some of the diagnostic reports that I have read; at least it has been advocated. Malignancy has been found in at least one case. I am happy that you read the LANCET editorial. It expresses a great deal in a few words.

Dr. Goodwin's 8-year-old girl is the youngest of the cases to date. The youngest reported case I reviewed was 23 years of age.

Regional enteritis has been discussed in many of the reported cases as a possible etiological factor.

I was very much interested in Dr. Hinman's discussion of yesterday because this might possibly give us some leads in understanding this perplexing disease.

We have erected no guide-posts, but if we have quickened your curiosity and increased your index of suspicion, I am sure that is what Dr. Ormond had in mind when he presented the original paper before this Association in 1947.

BILATERAL SIDE-BY-SIDE CUTANEOUS URETEROSTOMY IN THE MIDLINE FOR URINARY DIVERSION

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From the Urological Service of the Veterans Administration Hospital, Boston, Mass.

In patients where disease has either irreparably impaired the function of the bladder or has led to its surgical removal, the problem of urinary diversion presents itself. There are a number of ways of accomplishing this, and each surgeon, according to his own best judgment, tries to use that method which will most satisfactorily combine preservation of renal function and avoidance of complications, such as hyperchloremic acidosis and attacks of pyelonephritis, with the least handicap to the patient in the conduct of his daily life.

Recently we had such a patient upon whom a little-used method of urinary diversion was employed with great success, and therefore we wish to call attention to this.

CASE REPORT

G. B. C. (BVAH No. 45648), a 70-year-old white man, entered the hospital with a 2½ year history of difficult and frequent urination by both day and night, repeated episodes of gross hematuria with clots, and the loss of more than 50 pounds of weight. He had refused conventional medical care, relying on readings from Christian Science practitioners. However, eventually he had become so weak that he could no longer take care of himself and therefore was brought to the hospital in an ambulance. Examination showed an elderly man, weak, pale and emaciated, who became dyspneic on merely talking. However, except for these findings, physical examination was not remarkable. His urine was grossly bloody, and his hemoglobin was found to be 5.2 gm. and his hematocrit 17 per cent. Except for some elevation of his nonprotein nitrogen, his blood electrolytes were within normal limits. Some days later, after he had received 9 blood transfusions, cystoscopy was performed. An extensive fungating tumor occupied a large part of the bladder. Biopsy showed transitional cell carcinoma, grade 4. Intravenous urography showed marked bilateral hydronephrosis and hydroureters down to the bladder (fig. 1). X-rays did not reveal metastases.

An exploratory operation through a left paramedian incision disclosed no evidence of abdominal metastatic spread. Accordingly, cystectomy, including total prostatectomy and seminal vesiculectomy, was performed, and a large panel of overlying peritoneum was removed en bloc with the bladder. Finding both ureters to be dilated and thickened, and mindful of the recent work of Swenson[1] on children with mega-

FIG. 1. Preoperative intravenous urogram (at 4 hours) shows marked bilateral hydroureter and hydronephrosis.

[1] Swenson, O. and Smyth, B. T.: Aperistaltic megaloureter: Treatment by bilateral cutaneous ureterostomy using a new technique. Preliminary communication. J. Urol., **82**: 62–67, 1959.

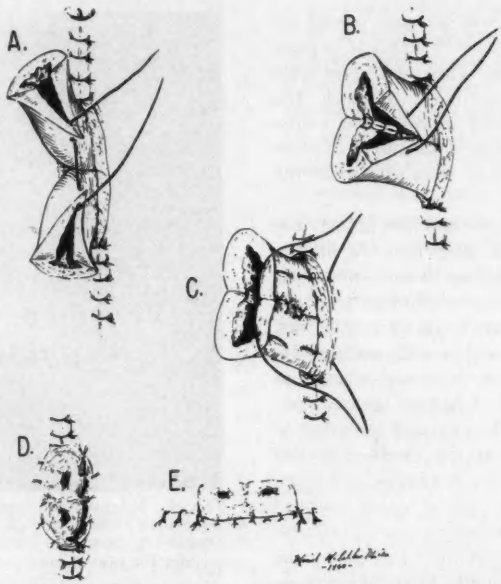

FIG. 2. Technique of bilateral cutaneous ureterostomy. *A*, ureters are brought out side by side through wound projecting at least ⅝ inch beyond skin. Each ureter is then incised upward for ½ inch on side adjacent to other ureter. First interrupted suture of fine chromic catgut is taken to join apices of incisions. *B*, edges of incisions are sutured together with interrupted fine chromic catgut thus creating a common stoma for both ureters. *C*, sutures of fine chromic catgut are placed all about stoma in order to evert it, fold it back on itself, and unite it to skin edge. *D*, sutures have been tied and have folded back cuff of stoma and mucosa and approximated it carefully to skin. *E*, lateral view of *D* shows that double-barrelled stoma projects at least ⅛ inch above skin level.

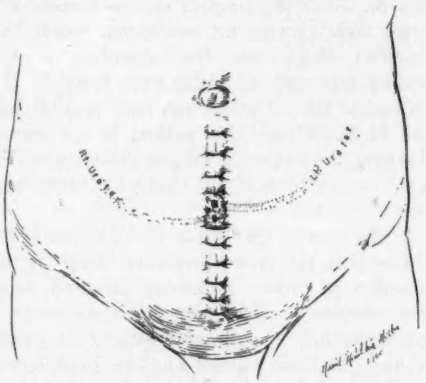

FIG. 3. Sketch of double cutaneous ureterostomy stoma in middle of incision—or preferably somewhat above middle.

loureters, it was decided to perform bilateral cutaneous ureterostomy, bringing both ureters out on the abdominal wall, side by side through the middle of the wound. Therefore the peritoneum was stripped away from the abdominal wall on both sides higher than usual, and then each ureter was led extraperitoneally around the peritoneal cavity and brought out beside the other ureter through the middle of the abdominal wound, projecting at least 1½ cm. beyond the skin. A round buttonhole to accommodate the ureters together was cut in the rectus fascia and also in the skin. Each ureter was then slit upward for 1½ cm. on the side adjacent to the other ureter, and then the edges of the incision in one ureter were sutured to the corresponding edges of the incision in the other ureter, thus creating a common terminal stoma (fig. 2). The wall of this stoma was then everted and folded back on itself for ¾ cm. to form a cuff covered with mucosa, the cut end of which, including the mucosa, was sutured to the edge of the buttonhole which had previously been made in the skin. This left the stoma everted and protruding for about ¾ cm. (fig. 3). To ensure good urinary drainage during the immediate postoperative

period, a soft rubber catheter was passed up each ureter to the kidney pelvis and held in place by suturing to the skin. These catheters were removed in 12 days, and never replaced. The patient made a satisfactory recovery and, before leaving the hospital, was fitted to a Torbot ileostomy bag, which was trimmed to fit the stoma.

That was 8 months ago, and the patient has been checked at intervals since then. At first he had some trouble with leakage of urine where the wound ran under the flange of the bag. However after a while the bag got to fit very well with absolutely no further trouble with leakage. He changes the bag once a week, re-cementing it to the skin with two types of Rutzen cement—one of which he applies to the skin and the other to the bag. The skin about the double-barrelled stoma is in a very healthy condition, and there is no retraction or stenosis of either ureteral ostium, each of which accepts a size 16 catheter easily (fig. 4). The patient feels well and looks well and has gained 45 pounds. Physical examination and x-rays reveal no metastases. Hemoglobin is 14.6 gm. and hematocrit 42 per cent. The blood urea nitrogen is now normal, as are his electrolyte determinations such as sodium, potassium, chlorides and Co_2 combining power. The patient has had no attacks of pyelonephritis. Intravenous urography 6 months after operation showed that both kidneys and ureters had returned to normal (fig. 5). Since the surgical specimen showed a large, highly malignant carcinoma, which had extended deeply into the muscularis of the bladder (although no nodes were found in the perivesical fat), it seems not only possible but also probable that this patient is not cured. However, the method of urinary diversion, which is the main subject of this paper, has functioned very well indeed.

FIG. 4. Photograph of double cutaneous ureterostomy stoma taken 6 months after operation. No retraction and no stenosis. Ileostomy bag fits without leakage. Note excellent condition of skin.

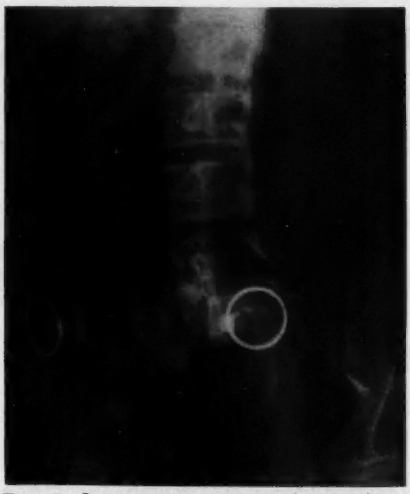

FIG. 5. Intravenous urogram (at 6 minutes, oblique view) shows complete return to normal of bilateral hydroureter and hydronephrosis 6 months after operation.

At the present time many urological surgeons believe that the ureteroileostomy "loop" is the procedure of choice for urinary diversion, as it best conserves renal function with a minimum of hyperchloremic acidosis and attacks of pyelonephritis, and also imposes a not-too-troublesome burden upon the patient in the care of the collecting apparatus. However, in the case of a patient whose ureters are dilated, and who is not so obese that the ureters are too short to reach 1½ cm. beyond the level of the skin in the midline, the afore described procedure of bilateral side-by-side cutaneous ureterostomy in the midline should be seriously considered as

probably superior to a ureteroileostomy "loop." The urine from both kidneys is carried more immediately and physiologically by the ureters to the skin where it is collected in a single ileostomy bag. More important, the absence of a conduit of a loop of ileum automatically rules out the possibility of hyperchloremic acidosis from absorption from a bowel segment, such as has been described recently by Creevy[2] as taking place in a number of cases where "loops" had been performed on patients whose ureters were greatly dilated and whose renal function was markedly impaired. Furthermore, since the surgical construction of a "loop" of ileum, the anastomosis of both ureters thereto, and the re-establishment of the continuity of the ileum by end-to-end anastomosis do not have to be performed in the case of cutaneous ureterostomy, the whole operation is greatly simplified and shortened, and the potential possibility of complications is automatically lessened. This simplification and shortening of the surgery not only is important in poor-risk patients, but also is appreciated by the operating surgeon.

[2] Creevy, C. D.: Renal complications after ileac diversion of urine in non-neoplastic disorders. J. Urol., **83**: 394–397, 1960.

In cases where the ureters are essentially normal—neither dilated nor thickened—cutaneous ureterostomy in the past was frequently followed by stenosis at the stoma, necessitating the constant and undesirable presence of an inlying ureteral catheter. However in those days, folding back of the ureter on itself to form a cuff of everted and projecting ureter, followed by careful approximation of the cut end of the ureter and mucosa to the skin edge, was seldom practiced, and it seems quite possible that the use of this technique might prevent stricture at the stoma. Certainly in the case of ureteroileostomy "loops," stenosis of the ileal stoma used to be common when the ileum was sutured flush to the skin, but now has practically disappeared with the technique of folding the ileum on itself, and suturing this cuff of everted and projecting ileum carefully to the skin edge. Investigation of the possibility of using this technique successfully in the case of normal ureters might pay dividends in lessening the number of cases in which the creation of ureteroileostomy "loops" was deemed to be indicated.

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A CALIBRATED RADIOPAQUE PENROSE DRAIN

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The acceptance of the soft latex tubing commonly referred to as a "Penrose drain" is attested by its continuing frequent use. In a high proportion of urologic open surgical procedures a Penrose drain is inserted to provide egress of extravasated urine and purulent secretions. It drain retracted into the wound. In both cases the resulting problems might have been avoided had it been possible to detect the presence of these drains. Another problem in a medical center concerns advancing the drain. A house officer is usually advised to advance the drain on alternate

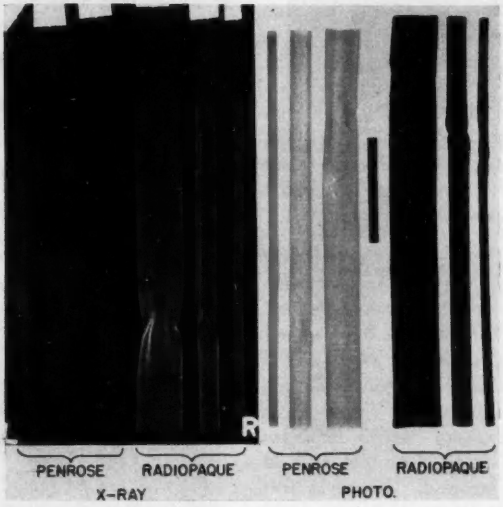

FIG. 1. Radiogram and photograph illustrate appearance and radiopacity of Penrose and calibrated radiopaque drains.

may eventually be possible to dispense with drains just as we seem to be dispensing with splinting catheters. For the present, however, we need the drain.

Shortcomings in the familiar type of latex tissue drain have come to our attention through mishaps. We have seen 2 patients with persistent drainage from an incision where the Penrose

The contents of this paper reflect the personal views of the authors and do not reflect official Air Force policy.

Animal experiments were conducted according to the Rules Regarding Animal Care as established by the American Medical Association.

* Associate resident in surgery.

days with a definite target date for complete withdrawal of the drain. Sometimes he incorrectly estimates the length of the drain and advances it more or less than the optimal distance.

In an attempt to solve these two minor problems we conceived of a radiopaque Penrose drain which was stamped with a centimeter scale. Upon writing to Dr. William Gants of the Davol Rubber Company we found that our idea was not original. A radiopaque drain was being tested at the Washington Hospital Center. Through the kindness of Dr. Gants a number of samples were made available. These drains are made of latex

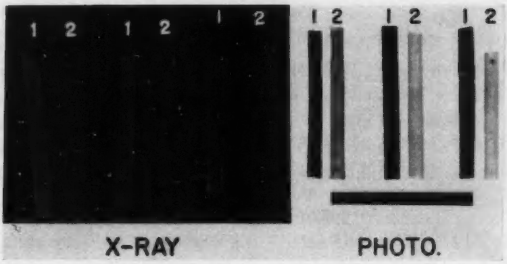

FIG. 2. Drains implanted 5 weeks. The new drains (labelled *1*) show no loss of calibrations or radiopacity.

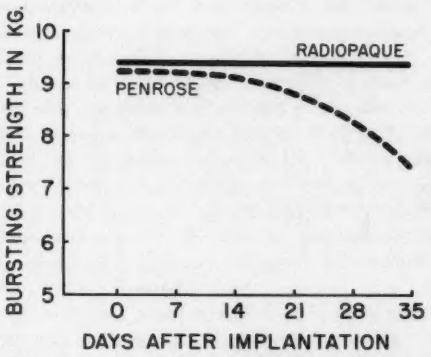

FIG. 3. Bursting strength changes with implantation. New drains show no loss of bursting strength.

to which barium sulphate and cadmium solenide have been added, a preparation used for many years in other rubber goods in which radiopacity is a desirable feature. Figure 1 shows the radiopaque nature of the new drain compared with the radiolucency of the usual Penrose tubing. The new tubing has a bright red color which identifies it as being x-ray opaque.

EXPERIMENTAL STUDY

The graduated radiopaque drains were tested for tissue tolerance, maintenance of bursting strength and permanence of the radiopacity and the calibrated graduations. Thirty-six quarter inch standard Penrose drains and quarter inch radiopaque calibrated drains were randomly implanted in the subcutaneous tissues of white Chester pigs. These drains were harvested at 1 week intervals over a 5 week period.

FIG. 4. Radiopaque drain in a patient.

Tissue reaction to both types of drains was minimal and approximately equal. The radiopacity and the centimeter graduations were well maintained in the new drains even after 35 days of implantation (fig. 2). Although the conventional Penrose drain showed some deterioration of bursting strength during the 35 days of contact with tissues, the radiopaque drains maintained their original strength during the same period of observation (fig. 3).

CLINICAL STUDY

The opaque red Penrose drains have been used in more than 100 patients in the past 9 months. Figure 4 shows an x-ray of the opaque drain in the right flank. We have had no unfavorable com-

ments concerning their use, save one. They seemed to one observer to be more slippery. The centimeter scale has enabled us to give more specific instructions concerning the advancing of the drain. We do not have to guess; we know what length of Penrose remains in the patient. The drain can be detected by x-ray if it should retract into the depths of the incision.

CONCLUSION

Attention is called to a modification of the Penrose tubing used for post-surgical incisional drainage. The new drain is marked with a centimeter scale and is x-ray opaque. It has been used successfully in over 100 patients. The modifications made in this drain appear to be useful and worthy of general acceptance.

DISCUSSION

DR. BEN D. MASSEY (Pasadena, Cal.): I am very pleased with the ingenious method that Dr. Chute has suggested. This should be an excellent method for diversion of the dilated ureters.

About a year ago I did the same thing for a single ureter on a man on whom I had done a cystectomy and ureterosigmoidostomy for carcinoma about ten years ago. He had a single kidney with a dilated ureter and was having pyelonephritis about once a month. Interestingly enough, his blood chemistry values were still practically normal.

The ureter was brought to the skin, a generous cuff was developed and sutured to the skin. We then followed the suggestion of Woodruff and kept normal saline packs on the cuff for one week. There was initial discoloration of the cuff and then it developed very nicely. One year later there was a good bud and no stricture of the opening. The patient managed ureterostomy with a Pierce ileostomy bag.

This patient was polyuric with reversal of his day and night ratio. During the day the bag was emptied on a time basis. At night the capacity of the bag was insufficient, and the kidney would become overdistended and an attack of pyelonephritis resulted. The problem was solved by inserting a large cork with connector into the opening of the bottom of the bag. This was attached to a tube and bottle. No further fever was experienced and the patient died recently of cardiac disease at the age of 69.

DR. REED M. NESBIT (Ann Arbor, Mich.): Mention was made of the collecting device. One of the patients who had had a cutaneous ureterostomy done by one of my associates discovered a way of handling his collecting device which was leaking all the time. He was quite ingenious.

He simply made a doughnut-shaped piece of foam rubber which he placed between the gadget and the skin. The fluctuations of pressure were all taken care of. The ACMI people are now manufacturing it under Dr. Lapides' name, I believe. It is a "no leak" device.

One question should be asked in regard to this side-by-side midline matter. Those who are anatomists and physiologists should inform us whether there is any risk of necrosis of ureters in the adults who are dealt with in this manner. Dr. Bischoff, what would your opinion be?

DR. BISCHOFF: I think there would be no danger. I am sure it is a very good method.

DR. NESBIT: There is no risk of getting necrosis?

DR. BISCHOFF: No, I am sure there would be no danger.

DR. NESBIT: Our program is now over. I want to express my gratitude to you gentlemen for allowing me to be the president of this, the most distinguished urological society in the world.

Before we induct our new President into office, our Secretary has an announcement to make.

SECRETARY ENGEL: First of all, I would like to express the appreciation of the society to Dr. Cerny for the excellent job he has done in handling the projection equipment. I think we should give him a big hand. (Applause)

PRESIDENT NESBIT: Will Dr. Harry Spence and Dr. Ben Massey please conduct the new president to the platform? (Applause)

Dr. CARL RUSCHE (Los Angeles, Cal.): Gentlemen, being elected president of this outstanding organization is an honor for which I am deeply grateful. The meeting, as you know, has been numerically and scientifically one of the finest we have ever had, and I feel we are deeply indebted to Dr. Nesbit and our hard-working secretary, Dr. Engel. They have really done an outstanding job. (Applause)

It has been very stimulating indeed to see so many of the young men and hear their very fine papers. This is the thing we need in this organization; and I am sure that with the election of eight new members, all of whom will give us the same type of program we have had this year, we are all going to look forward to, as the old saying goes, "The man who looks ahead today is prepared for tomorrow, and being prepared for tomorrow is the key to success."

From the reports and discussions I have had with the men in San Francisco I know we can look forward to a very fine meeting on the West Coast next year.

I feel that I should repeat again that it is no farther from New York to California than it is from California to New York. We are looking forward to all of you being at Los Vegas next year. (Applause)